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THE SUPPLY OF ELECTRICITY BY MUNICIPAL AUTHORITIES.

THERE is still a good deal of reasonable doubt existing as to whether a municipal authority is more fitted than a joint stock company to control a public supply of electricity. Much has been said and written upon the advantages of municipal ownership, and while there is much to commend in such an arrangement there are drawbacks of a very serious nature. We are not prepared to say that the benefits derived by a community from municipal ownership more than compensate for the disadvantages. There can be no gainsaying the fact, that if in the inauguration of an electricity supply by a local authority every detail were carried out on sound commercial principles, good results might accrue to the undertaking. If, from the selection of the consulting engineer to the lighting of the lamps every factor in the system were sound, a corporation would occupy an unquestionable position. But we are afraid that in electric lighting municipal authorities are more or less involved in the vagaries of chance. They may have the good fortune to secure a consulting engineer who will select the only scheme which is suited to their requirements and conditions. On the other hand they may have the advice of a perfectly honest man, but one who, unfortunately, possesses prejudices in favour of a particular system under all conditions. The defects in such a system may be only apparent when too late to remedy, and when the opportunity of organising a sound business has gone. In the internal arrangements of a central station they may be still more unfortunate. A municipal authority will usually place absolute reliance in their consultant, and they may have plant installed designed for anything but economical working. It is, however, unnecessary to multiply instances in which a municipal authority may go unwittingly astray. There are many advantages to be derived from ownership by local authorities, and if all things were equal, greater benefits might result to consumers from a municipal supply station than from one worked and controlled by a public company. Private enterprise, however, rarely suffers from the troubles incidental to municipal supply. True it may be burdened with an incapable and expensive directorate, but it may possess an efficient manager. There is for the most part no desire to do business otherwise than on a purely commercial footing, there is none of the officialism and petty jealousy which is often enough the bane of corporation work, and there is no obligation to supply electricity in a district which is not likely to provide a fair return. Of the value of the work done by private enterprise in the past there can be no question. It was left to private enterprise to prove the commercial and practical advantages of an electricity supply; it is to private enterprise that we are indebted for the majority of the supply stations, and to private enterprise we must look for the future developments which affect the utilisation of electricity for light and power

purposes. The question of municipal supply has recently received attention from Mr. Robert Hammond in a paper read by him before the Municipal Engineers at the meeting recently held at West Bromwich. In many respects it is an admirable paper, but it is marked by many of the defects inseparable from a too enthusiastic advocacy of electric lighting. Still we cannot help commending the lucid arrangement of the subject, though we are not quite prepared to accept the deductions. To show the relative positions between municipal authorities and joint stock companies as suppliers of electricity, it will be useful to give some of Mr. Hammond's figures. At the present moment the total capital invested in central stations in actual operation is 4½ millions, but of this only £474,000 represents the capital invested by local authorities. But the desire of municipal bodies to become suppliers of electricity is fast outstripping the enterprise of the companies, for we find in the electricity works in construction the companies are represented by an invested capital of £79,000, while the local authorities have works in hand of the value of £766,000. The spirit of progress now possessed by the local authorities is still more marked in the stations decided upon, the construction of which has not yet commenced. The companies have £25,000 against £807,000 for the local authorities. These are significant figures, and show clearly enough that new stations will be mainly constructed by municipal authorities. It has been held by some, and we note that Mr. Hammond adopts the views, that trading in electricity by local bodies may be considered on precisely similar grounds to the supply of gas and water. We are not convinced of the logic of this argument, because the electric light will not be, at any rate during the next few years, other than a luxury; gas is not a luxury; still less so is water. We fail to see, therefore, that the argument is of much weight. It has been said, and will be said again, no doubt, that there will be many economies effected shortly which will lower the price of electricity. We are not over sanguine that the price of electricity will be materially reduced from present rates, unless by means which will practically render obsolete all present modes of generation. In spite, however, of the energetic measures which municipal bodies are pursuing in regard to electric light powers, much will remain in the hands of the joint stock companies. No doubt if fair arrangements can be made, local authorities will be disposed towards taking over many of the existing central stations long before the expiry of the provisional orders, but they must not be expected to pay exorbitant sums, or they will prefer to wait. When the time comes for the municipal authorities to consider the advisability of taking over stations which are in the hands of companies, there will be many a difficulty raised which will not always result in advantage to the company. There have not been wanting at different times signs of possible conflict between the local authorities and supply companies. At Brighton, for instance, the corporation at the present moment are competing side by side with a supply company. Attempts have been made to square the differences between the two, for it is patent that the competition will be most injurious to at least one of the parties concerned; but these differences remain unsettled. The company were first in the field, and, we believe, worked for some time under a license. Then the corporation wanted to become suppliers of light, and it might have been expected they would have taken over the existing works; for some reason or other this was not done, and the corporation successfully opposed the application of the company for a provisional order. At the present moment the corporation are working under a provisional order, while the company are running their central station and supplying customers without one. There is nothing, however, to prevent the Brighton company from continuing their supply; the real difficulty will be in making extensions. The precise terms on which a corporation should acquire an electric light business before the expiration of a provisional order, must depend on a variety of circumstances. They would need to be a little less absurd than the clause which has been inserted in the Leeds Electric Light Company's order, and which Mr. Hammond deftly brought before the municipal officers at West Bromwich. The clause sets forth that if the corporation wish to acquire the business of the Leeds Company between the years of 1901 to 1912, they can do so "by the issue to the company of such an amount of Leeds Corporation stock as will produce by the interest or dividends thereon an annuity of 5 per cent. per annum upon the capital account of the company." The shareholders would, in fact, obtain an absolutely safe dividend for all time to come, in exchange for company shares which would be subject to all the changes and fluctuations affecting the soundest business. This clause is fairly representative of the manner in which the Leeds Corporation have looked after their interests. It must be mentioned that the most moderate terms would be obtained by the company if the corporation were to wait for the expiration of the order before purchasing. Under such circumstances the company would be compelled to sell, upon the corporation paying the then value, of all lands, buildings, works, materials and plant, without addition in respect of goodwill, or any profits which might have been made. Considering these things it would be well, wherever possible, for companies to make fair offers lest they should receive worse. Mr. Hammond reiterates in his paper the well worn, but still inaccurate statement, that electricity at 5d. per unit is equivalent to gas at 2s. 6d. per 1,000 cubic feet. Very little would be gained in combating these statements, but we would be more prone to generally accept Mr. Hammond's statements if many of them were a little less roseate in their hue. He also told his hearers that the costs of production in many places are as low as 4d. per unit, but in fairness he should have added that in many others the costs are as high as 8d. These, as well as other statements which we have not space to comment upon, seriously detract from the value of the paper as a contribution to serious literature.

AUTO-CONDUCTION: A NEW METHOD OF ELECTRIFYING LIVING SUBJECTS.

IN electro-therapy, as practised by expert scientists (not expert advertisers), there are three principal methods of electrification employed, namely (1) franklinisation, (2) voltaïsation, and (3) faradisation. The designation corresponds to the character of the source of electricity employed. To these Mons. A. D'Arsonval has added two others, which he terms (1) sinusoïdal voltaïsation, and (2) electrification by means of high frequency currents. Of these latter methods the first is described in detail in the *Comptes Rendus*, March

21st, 1891, and the *Archives de Physiologie*, January, 1892, and April, 1893, whilst the other is demonstrated in papers published in the *Proceedings* of the Société de Biologie, 1891, and the *Archives de Physiologie*, April, 1893.

In all these systems or methods of electrification the human body is placed in material communication with the source of electricity by means of appropriate conductors, which constitute the rheophores. But in a new method recently described by D'Arsonval in the *Comptes Rendus* for July 3rd (Vol. cxvii., No. 1, p. 34), and named by him "Auto-conduction," the individual undergoing treatment is completely isolated from the source of electricity. The currents which circulate in the body of the subject are not brought to it through the medium of conductors, but they originate in the tissues themselves, and play the part of a closed induced circuit, which is entirely within the body.

Some intimation of the means whereby Mons. D'Arsonval brings about these phenomena was given in a paper read by him before the Société de Biologie, February 4th, 1893, and he further elucidates them in the paper in the *Comptes Rendus* to which we have referred.

The currents are able to acquire considerable strength, but they produce no inconvenience to the individual in whose body they are set up; in short, the individual may be quite unaware of their existence, but Mons. D'Arsonval states that they are nevertheless able to act very energetically upon the vitality of the tissues. He obtains this result by immersing the subject either entirely or partially in an oscillating magnetic field of very high frequency. The field is produced by means of the following apparatus:—An open-work cylinder or skeleton cylinder of suitable dimensions is constructed of some insulating material such as wood, glass, &c., and around it is rolled in one or several layers a thin electric light cable which is also insulated. This device constitutes a kind of solenoid, in the interior of which is placed the subject to be electrified.

The solenoid is traversed by the discharge of a condenser, rendered oscillatory by the process described by D'Arsonval before the Société de Physique, April 20th, 1892. As a condenser, he employs from two to a dozen Leyden jars arranged in two batteries in cascade; the diameter of each jar is 20 cm. and the height of the covering 50 cm. A transformer giving about 15,000 volts is introduced, and this is actuated by a Siemens alternator, without iron, able to give at the maximum a current of 12 ampéres at 350 volts. The frequency is 60 periods per second.

Mons. D'Arsonval describes a number of experiments, which show that the induction power of the solenoid on conducting bodies placed in its interior is very remarkable.

In estimating the power of the magnetic field he makes use of the fact that when a mercury thermometer is placed in the solenoid, Foucault currents are generated in the mercury, and the temperature rapidly rises. This calorific effect measures the product of the frequency into the square of the current. It is stated that this method of electrifying living subjects exercises very marked effects upon the phenomena of nutrition.

To the communication in which auto-conduction was described, Mons. A. Cornu added a note in which he stated that he and Mons. Marey, whilst electrified by this system, had transported through their bodies enough electrical energy to bring 6 lamps (125 volts, 0·8 ampères) to incandescence without experiencing the slightest inconvenience or appreciable sensation.

Dr. Lewis Jones's Experiments.

In our contemporary, the *Electrician*, for July 21st, appears an article by Dr. Lewis Jones on "The Duration of Discharges of Induction Coils." He connects one terminal of the secondary to a brass cylinder, revolved by a motor, and covered with iodide starch paper; the other terminal is connected to an insulated platinum wire, which is held against the paper and moved from end to end of the rotating drum. The results he obtains are that the break discharge lasts a considerably longer time than the break, which latter is cut short by the former; at least this appears to be the case in the coil Dr. Jones employed, which possessed a short stiff spring in its contact breaker; with a more flexible spring this would possibly not be the case. Dr. Jones finds from the measurements of the lengths of the tracings obtained on the prepared paper that the mean duration of the break secondary discharge is ·0134 second, while that of the make is ·0046, but as the latter is cut short, this figure would not be of much value except for this special case. The result of this investigation is to show that with an ordinary induction coil circuited through something about 1,000 ohms, the time intervals during which there is no current produced in the secondary circuit are small, in fact, only about 5 per cent. of the total time. No sign of oscillation of the secondary current is apparent in the traces, but from the nature of the method it is very doubtful whether oscillatory alterations in the current strength would show perceptibly if many oscillations take place in a single discharge, and Helmholtz has observed as many as 35 in $\frac{1}{10}$th of a second. Blasema, Helmholtz, and Bernstein, have all shown, experimentally, that oscillations do take place in the secondary, and it hardly seems possible that the external resistance of 1,000ω, should damp them out when the secondary has as high a resistance as 2,750ω, which was its value in Dr. Jones's coil.

Current Density for Copper Deposition.

In the electro-deposition of copper from solutions of its salts it has been observed that, if with a given exposed surface of cathode, a certain current strength be exceeded, the deposit assumes a curious chocolate-brown colour when the solution is concentrated, or a dead black colour when the solution is dilute. It is often stated that this modified form of deposit is but copper in a finely divided state. Magnus, however, long ago expressed his belief that it consisted of copper hydride, and devised a theory for its explanation, based upon current density. Weber also admitted the composition of the deposit to be copper hydride, but was of opinion that its occurrence was associated with the velocity of the migration of the copper ions. Magnus's measurements of current density with a view of determining the critical density were not very concordant, and since Weber's calculations of the ionic velocities admitted errors of 10 per cent. they cannot be regarded as satisfactory. Hence, S. Sheldon and G. M. Downing have submitted both aspects, namely, the critical current density for copper deposition, and the absolute velocity of migration of copper ions to a careful investigation; this is described in No. 1 of the *Physical Review*. In this paper they consider the causes which affect the critical current density for copper sulphate, *e.g.*, the influence of rapidity of flow of the solution, the influence of temperature and of concentration. And from a consideration of their results they deduce an approximation formula for determining the critical current density when the specific gravity of the solution is known: this may be of value for industrial or experimental purposes, and is as follows:—

$$D_{18} = (d - \cdot 9987)\ \cdot 65.$$

The excess of the specific gravity of solutions at 18° C. above ·9987 (the density of water at 18° C.) is very nearly proportional to the percentage of salt contained, hence the above equation can only be a few per cent. wrong. In this equation d is the sp. gr. of the solution, and the calculation gives the critical current density in ampères per square centimetre of cathode surface. This is the limiting current allowable when the solution is at rest. By means of circulation at the cathode surface, however, this value may be increased many times. The paper concludes with some experimental results on the velocity of the copper ions and the mathematica discussion of them.

ARC LIGHTING.

BY E. TREMLETT CARTER.

(*Continued from page* 62).

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VIII.

FOLLOWING the foregoing lines of design, but replacing the C.G.S. measurements by English ones, we may use the set of formulæ given below, to design a transformer for running an arc lamp from mains at a high voltage.

$$l_1 = 480 \frac{W}{C_1} \text{ feet.}$$

$$S_1 = \frac{C_1}{\Delta} \text{ square inches.}$$

$$R_1 = 0{\cdot}0000081 \frac{l_1}{S_1} \text{ ohms.}$$

$$S_2 = S_1 . \frac{E_1}{E_2} \text{ square inches.}$$

$$l_2 = l_1 . \frac{E_2}{E_1} \text{ feet.}$$

$$R_2 = 0{\cdot}0000081 \frac{l_2}{S_2} \text{ ohms.}$$

$$\lambda = \sqrt{\frac{A}{1 - \frac{p}{100}}} \text{ inches.}$$

$$\lambda_1 = 4 (\lambda + 2 t) \text{ inches.}$$

$$\frac{12 A l_1}{2 t + 4 \sqrt{\frac{A}{1 - \frac{p}{100}}}} = \frac{E_1 \sqrt{2}}{2 \pi n B} \times 10^8.$$

From the last of these equations the section of iron in square inches may be determined. The symbols, C_1, R_1, R_2, p, n, W, E_1, and E_2, have exactly the same meanings and magnitudes as before; while B is the induction in C.G.S. lines per *square inch* of iron, and Δ is the current density per *square inch* of copper. All other symbols have the same meanings as before and the new magnitudes which are attached to them in the equations.

In series working the principles of design of transformers are the same as in parallel; but there are important differences in detail. The primaries are all connected in series, and a constant current is maintained in them. Usually each transformer supplies only one lamp; but, if more are supplied, these must be put in series on the secondary circuit. The coefficient of transformation is equal to the ratio of the secondary to the primary current, and is often unity. In this case the primary current and voltage will be equal to the secondary current and voltage, at the respective coils; and the only advantage will be a safe potential at all points on the secondary. The primary current in this case will be about 10 amperes. In other cases, where many more lamps must be supplied without increasing the primary E.M.F., a primary current of 30 amperes is used, and the transformer raises the voltage and diminishes the current in the secondary, the coefficient of transformation being one-third. This system is further described in a later section on the Westinghouse arc-light system.

Series transformers are cut out by short-circuiting the secondary, and must never have that circuit opened. The effect of cutting out in this way is to set up a large counter magnetomotive force in the iron; so that the iron and copper losses are small, and the primary voltage falls to a low value. Parallel transformers must be cut out by opening the secondary circuit, which must never be short-circuited; and the effect of the open circuiting is to enormously increase the impedance of the primary coil.

III.—*Design of a Generator for the Given Conditions.*

11. *Classification of Generators.*— In the first chapter the principal conditions met with in an arc light circuit were considered, and the requirements of the arc itself were briefly laid down. We have already seen in what way the cables and transmissive details must be designed in order that they may suit these conditions; and we shall now apply the same principles of design to the choice of, or construction of, the generator. That is to say, we must study the bearings of the requirements of arc lamps, arranged according to different systems, upon the size, electrical constants (voltage, &c.), winding and general proportions and construction of the dynamo. There will, of course, be different arrangements of these things according to the kind of circuit on which the lamps are placed—whether series, parallel, or transformer-parallel—as well as according to the number of lamps on the circuit, the number of dynamos employed to run the circuit, and whether the current is to be continuous or alternating. For convenience we may adopt the following classification of generators:—(*a*) Continuous current machines for running arcs in series; (*b*) Alternate current machines for the same kind of circuit; (*c*) Continuous current machines for low tension parallel working; (*d*) Alternate current machines for high tension parallel working with transformers; (*e*) Machines for running single arc lamps such as search lights.

12. *Continuous Current Dynamos for Series Lighting.*— It is a remarkable fact that by far the largest proportion of the arc lighting of the world is carried out on a system to which it is impossible to adapt a compound-wound self-regulating generator; that, in other words, the dynamo is incapable of being designed (at least, so far as present practice is concerned) so as to adjust itself to the requirements of series arc lighting. It is in spite of this defect, and because of the outweighing advantages, that the series system is so largely adopted. The earliest of a succession of unsuccessful attempts to compound wind the dynamo for constant current at constant speed at all loads was made by Deprez, who endeavoured, by combining a shunt excitation of the field magnets with an initial separate excitation, to produce an external voltage proportional to the external resistance of the machine. Deprez, however, failed in this attempt, because he had based the method upon the supposition that the permeability of the magnetic circuit would be independent of the degree of excitation, which is now known not to be the case.

Meeting this difficulty at the outset, it will at once be necessary to consider the various ways in which a dynamo can be made to deliver a constant current to a varying number of lamps arranged in series. The causes which tend to produce an alteration in the amount of current are:—(1) Variation of the number of lamps actually in the circuit; (2) variation of the distance between the carbons of one or more lamps, including the actual short-circuiting of the lamp by contact between the carbons at the moment of striking the arc; (3) variation in the speed of the dynamo, or want of adjustment of the speed to the output, as the case may be. The following methods have been adopted:—

(*a.*) *Variation of the Speed Proportionally to the Load.*— The power which the dynamo is required to supply electrically is equal to the product of the current into the E.M.F., and the current is to be constant. The power which the engine will supply to the dynamo is equal to the product of the speed into the torque on the dynamo shaft. The speed will always be such that the torque on the dynamo shaft is equal to the torsional resistance of the armature; and this latter is proportional to the current, and is, therefore, to be kept constant. If, then, the torsional effort of the engine—the driving torque—is kept constant, the speed, which will always adjust itself so that the torsional effort balances the torsional resistance, will therefore vary so as to maintain a constant current in the armature. In such a case the speed will be simply proportional to the voltage required, *i.e.*, to the number of lamps.

There are two methods of arriving at this result; either by coupling the dynamo to a prime mover which is set for constant torque at all speeds, or by interposing between the engine, which may run at a constant speed, and the dynamo, some form of variable reduction gear which is under electromotive control. The first of these requires that the engine shall be solely occupied in working the dynamo, and that the dynamo shall be only occupied on a series circuit. Either belts or ropes or direct coupling may be used, since the power absorbed by either of these arrangements of the machinery is simply proportional to the speed. The engine may be either a steam engine or a piston water motor, but gas and oil engines and turbine are not adapted to this system of working. All mechanical governing, in the true sense, must be dispensed with; but a simple electrical governor,

admitting the working fluid in such amounts as to keep the effort on the piston constant at all speeds may be used. The ordinary mechanical governor must be weighted or linked up so as to prevent a dangerously high speed, but must serve no other purpose. The engine must be chosen so that its full speed corresponds to full load, and must be capable of working economically at any lower speed. In order that the moving parts may be able quickly to adjust their speed to the sudden variations of load which may occur, only the smallest possible amount of inertia is permissible; therefore, the fly-wheel should be only heavy enough to prevent excessive fluctuation of angular velocity during each revolution. The conditions are here opposite to those of ordinary good practice, since a heavy flywheel is requisite in the best class of steam engines where an early cut-off of steam would otherwise induce great variation of speed. It may be necessary, in some cases, to adapt an automatic brake to the engine shaft, so arranging it that directly a variation of current occurs the surplus energy of the moving parts may be quickly absorbed; but if the governor is very sensitive, and if the parts are not heavy, this will not be necessary. The cut-off of steam will be fixed independently of the speed, except in so far as it will be necessary to admit a little more or less steam on account of variation in efficiency. We have, in fact, conditions in this system which would cause an electrical governor to admit *more* steam per stroke at low loads than at full load. The reason is, that at low loads the stroke will be taken very slowly, which will cause a very much greater liquefaction of steam in the cylinder than the normal amount, the governor admitting more steam to make up for this loss. This is, indeed, one objection to the system, at any rate in so far as it is proposed to use a steam engine supplied with ordinary saturated steam. For it will be found that when the load is a small fraction of its full value the engine will crawl round so slowly that there will be heavy cylinder losses. With a water motor in which a piston is used, the system has not these objections; but with ordinary turbines the variation of speed is too great to permit of their having a high efficiency except at full load. The system is in short, one which is admirably adapted to circuits containing a fixed number of lamps, where the only variations are due to changes in the lamp adjustments, but it is not suited to circuits in which the lamps may vary considerably in number.

In regard to the use of variable reduction gear it will be necessary to say but a few words, since this very desirable form of gear is still only imperfectly invented. When we have a reliable, efficient, durable and cheap gear which will transmit large amounts of power at speeds varying from a maximum to zero, it will be time to devote serious attention to this method of working. For the present, we may content ourselves with the reflection that the invention is not inherently impossible, and that it is badly wanted in many branches of electrical engineering.

(*b.*) *By means of Dynamos with a Drooping Characteristic.*—The external characteristic of a series wound dynamo is a curve which rises from nearly zero where the current is zero to a maximum value, and then falls away either gradually or quickly towards zero. The falling or drooping portion of the curve is produced by the armature reactions and losses, as will be seen from fig. 20. In this diagram the upper curve, I, represents the total statical characteristic of the dynamo, or the relation between the total E.M.F. and the exciting current when the load is zero and the speed is constant; it is a curve analogous to the magnetisation curve of the iron in the field magnets, though not identical with it in form. From this upper curve we may plot the characteristic of the external circuit, or the relation between the current and the voltage at the terminals, provided we can find the amount of loss of volts due to the armature. These losses are mainly: drop due to the armature resistance, saturation of the armature core, and the demagnetising effect of the armature. The first is proportional to the current, the latter ones are approximately proportional to the square of the current. Deducting the losses from the curve, I, we get the external characteristic, E. Now it will be evident that by making the armature reactions and resistance large we may cause the drooping part of the characteristic to droop very rapidly. Let us consider the effect of this on the regulation of a dynamo supplying current to lamps in series. Suppose the normal current to be C_1 (fig. 20), there being, say, 50 lamps in the circuit. If, from any cause, the number of lamps is diminished, the resistance of the circuit will diminish, and there will be an increase of current. But when the current has increased to C_2, the E.M.F. has fallen, so that the increment of current for any given fall of resistance will be less than if there were no drooping in the curve. The steeper the curve in this part, the more rapidly will the E.M.F. fall off for any given reduction of resistance, and the more perfect will be the tendency to maintain a constant current. It will be evident that from the nature of things this method is not capable of maintaining an absolutely constant current; nor is it, in fact, capable of preventing very considerable changes in the current where the variations in resistance are more than a small percentage of the total resistance in the circuit. Still, combined with other means of control, this method is useful, inasmuch as it puts less stress upon those other means and renders them more prompt and sensitive in their action.

The practical means of arriving at the desired form of characteristic are as follows: increasing the armature reac-

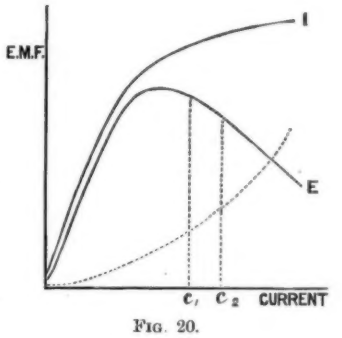


FIG. 20.

tions by increasing the proportion between the iron in the armature and that in the field; and increasing the constant resistance of the machine, either by adding to the resistance of the armature, the field, or the circuit immediately between the dynamo and the lamps. In regard to the economy involved in these methods, there is little that is good to be said; for the former will necessitate the use of saturated iron in the field magnets, and thereby the use of an abnormally large number of ampère-turns on the field coils; while the increase of resistance in any part of the machine, or just outside it, will involve a constant waste of power as well, The auxiliary steadying resistance may, as we have seen, be placed anywhere in the circuit; but it is preferable to have it outside rather than inside the armature, in order that the heat which it will dissipate may not require extra cooling surface on the armature surface. It may conveniently consist of insulated wire of sufficient carrying power, wound on an iron core to increase its self-induction. Economically, however, the method, though wasteful, may compare favourably with other methods. As regards the prime cost of the machine, the adoption of this form of characteristic will bring up the price for a given output. For the weight of copper on the field magnets will have to be considerably increased; partly because of the reduced permeability of the iron, and partly because of the increased leakage of magnetic lines; and if the armature has a higher resistance than is usual, there will be some alteration in the proportions which will make the machine more expensive to build. Notwithstanding all the objections, however, this method has found great favour as a partial solution of the problem, and machines built on this plan have been found to do very excellent work on series circuits.

(*c*) *By Means of Automatic Regulators of the Field Current.*—This method may either be used alone or in conjunction with the method (*b*). The essential principle of it consists in automatically shunting a portion of the armature current across the field coils, allowing only the remainder to excite the field magnets. In proportion as more or less of the total current is thus shunted through the regulator, so the ampère-turns on the field magnets will be less or more, from which it follows that the amount of shunted current must be increased in proportion as the E.M.F. of the machine is to be reduced. This may be effected by placing a variable

resistance, shunted across the field coils, under the control of a solenoid or other electro-magnetic device, the coils of which are placed in the main circuit. If the main current increases, the electro-magnetic pull will so act on a train of mechanism as to reduce the shunt resistance, and thereby cause more current to be diverted from the field coils. This mode of regulating will control variations both of the load and of the speed of the dynamo. It is commonly supposed that these regulators maintain a constant current in the external circuit, and many text-books state this to be the case. The idea is, however, incorrect; for these devices operate in a manner analogous to that of the ordinary centrifugal governor of a steam engine, and *require* a certain fluctuation of current to bring them into, and to keep them in, operation. This point, which is a vital one in the design of the appliance, can better be explained by reference to one particular form of regulator. The earliest form was that invented by Brush, and used by him to keep an approximately constant current in an arc light circuit. It is represented diagramatically in fig. 21. The current passes from

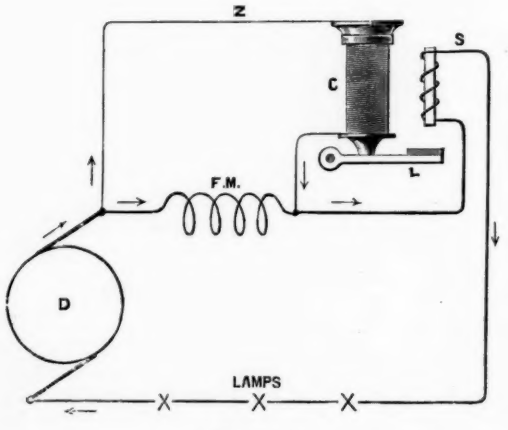


FIG. 21.

the dynamo, D, to the junction of the field coils and the shunt, part of it passing through the former F.M., and part through the latter, Z. Included in the shunt circuit is a pile of slabs of carbon, C, placed one upon the other in a press in such a way that the shunted current must pass from surface to surface of the carbons and overcome the resistance between their surfaces of contact. The lower part of the press constitutes a lever, to the further end of which is a soft iron slab, placed immediately below and in the attracting field of the solenoid, S. This solenoid carries the main current, so that any increase in that current will increase the pressure between the carbon slabs, and will reduce the resistances at their surfaces of contact. Immediately, the current in the shunt will increase, that in the field coils will be diminished, and the excitation and E.M.F. of the machine will drop, until a new condition of equilibrium is established. What will be the main current under this new condition of equilibrium? It will not be the same current as before, but the difference may be made small by careful design of the appliance. Let us suppose that the machine is to regulate between a terminal E.M.F., E_1 and E_2. Then the shunt circuit will have to vary between a resistance, Z_1 and Z_2. To effect this variation there must be a difference in pressure at the carbon press under the two conditions; and let the pressure when the E.M.F. is E_1 be f_1; and, when the E.M.F. is E_2, let it be f_2. Now there cannot possibly be two different pressures in the carbon press with exactly the same exciting current in the solenoid; so let there be a current, c_1, when the E.M.F. is E_1, and a current, c_2, when the E.M.F. is E_2. We shall, of course, desire to make the difference between these currents small; so we must design the solenoid, S, so that with a current c_1 it will exert a force, f_1, on the carbon press, and with a slightly greater current, c_2, it will exert the force, f_2; also, arranging the number and size of the carbon slabs so that with this variation in current, there will be the very much greater variation desired in the resistance of the shunt.

(To be continued.)

THE UTILISATION OF TOWN REFUSE FOR POWER PRODUCTION.

BY THOMAS TOMLINSON, B.E., Assoc.M.Inst.C.E.

IT is evident that we have entered upon the stage of municipally owned electric lighting and power plants. Municipal authorities are everywhere becoming alive to the value of an electric lighting order, and are therefore becoming increasingly reluctant to allow the powers conferred by such an order to pass to a private company. Cases do occur in which the municipal authority, having obtained an order, transfer it to a company; but they generally endeavour in such cases to secure better conditions for the resumption of the undertaking than are conferred by the Electric Lighting Act.

This municipalisation of the electrical supply industry is already having a very marked influence on central station practice, as is evidenced by the fact that the utilisation of the waste heat of refuse destructors has been recommended, in connection with electric supply, to the vestries of Shoreditch and St. Pancras; this waste heat is already so used, on a small scale, at Southampton (see a paper by Mr. W. B. G. Bennett, A.M.I.C.E., *Minutes* of the Association of Municipal and Sanitary Engineers, Vol. xv.), and a proposal has been made for a similar utilisation at Widnes (see ELECTRICAL REVIEW, April 7th, 1893). Tenders have also been accepted for an electric light plant working in connection with destructors at Ealing.

For sanitary reasons the local authorities are obliged to collect and dispose of a considerable quantity of refuse, and a keener appreciation of sanitary conditions having brought into discredit the old plan of disposal by tipping upon low-lying land close at hand to bring it up to building level, the refuse, if tipped, has to be brought further a-field; this, by necessitating long cartage, barging, or railing, much increases the cost of disposal, and so brings it on a level with, or above the cost of disposal by burning in destructors in the district served. The builders of destructors also have now brought them to such a pitch of perfection, that little, if any nuisance, is caused by their use. Both these causes are leading to their very wide adoption, and the London County Council has just had submitted to it an important report on the subject, to which I shall hereafter refer.

The idea of utilising the waste heat of these destructors, and so reducing, if not entirely repaying, the large cost of collection and disposal, is also greatly exercising the minds of the authorities, and in accordance with the old saying that "he who pays the piper chooses the tune," municipal engineers and electrical engineers called in as specialists, will have to form very definite ideas as to what the value of this waste heat is. The object of these papers is to help in this, principally by the statement and analysis of such facts, experiments, opinions and promises of performance as I have been able to get at.

To be perfectly orthodox, I should start with descriptions and illustrations of the principal types of destructors; but this has been done so often, so recently and so well, that it is unnecessary (see articles on "The Disposal of Town's Refuse," by Mr. H. P. Boulnois, M.I.C.E., begun in the *Surveyor*, July 13th, 1893). Besides, I am concerned in this paper with results, not design, and cheap secondhand criticism upon the labour of experts who have worked up through failure to the very admirable results now obtained, I do not believe in.

Before considering figures, I propose to consider the limiting conditions of the utilisation; these are the conditions of burning, the quantity of material available, and its calorific value.

In a very valuable report to the London County Council on "Dust Destructors," by Mr. Alexander R. Binnie, M.Inst.C.E., and Dr. Shirley F. Murphy, I find this general criticism: "We have already intimated that, as regards the best available means of preventing nuisance from destructors, the following points demand special attention:—

"1. The temperature obtained should be sufficiently high.

"2. The duration of exposure to a high temperature should be sufficiently long.

"3. *All* the vapours escaping from the refuse should be heated to a sufficient extent, and there should be no possi-

bility of the escape of any un-decomposed vapours into the chimney shaft."

It is of extreme importance that these points should be well considered by anyone proposing to use refuse destructors as steam makers, and for these reasons :—Clause 1 implies the use of forced draught, and, so far as I can find, practical experience, as evidenced by universal practice, says it must be by steam jets. Now Mr. Watson, in a paper read before the British Association (*Engineering*, September 30th, 1892), records, as the result of a valuable experiment made on a "Horsfall" destructor at Oldham, that "about $\frac{7}{16}$ths of the total steam available is used in the steam blast." I shall allude to this again when dealing with the figures of the experiment ; but the fact as here set down is suggestive.

Clause 2 is of extreme importance ; practically, I should say, if adhered to, it makes impossible the placing of the boilers in a position to enable them to best utilise the heat, *i.e.*, over the hottest part of the fire ; especially if taken in connection with clause 3, which practically implies that you shall bring the gases given off by the drying refuse, at the back of the fire, forward over the hottest part, and shall there subject them to the highest temperature you can get, and for the longest time possible, and you will materially reduce that temperature by placing a large mass of comparatively cold water above.

In this connection I may say that I was much puzzled to account for the evaporation rate, per pound of ashbin refuse, obtained at Birmingham, which I could not reconcile with other figures. Prof. Forbes furnished the solution : "It was necessary there to keep up steam for the treatment of the excretæ, and steam was got up from these furnaces by putting the boilers directly over the furnace. In consequence of this, the combustion is extremely imperfect. The large cooling surface of the boilers impedes the combustion in an effectual degree. In most cases where boilers have been used to generate some steam, the boilers have been put away, and after the gases have passed through the flue, they then pass by the boiler, and the error has been in the opposite direction." This seems the proper place to point out that the only figure of evaporation given in this L.C.C. Report (1·79 lbs. of water per pound of ashbin refuse), and the deduction of the calorific value of ashbin refuse burned in a destructor as "about one-fifth the value of an equal weight of coal" is obtained at Birmingham and evidently under conditions which do not satisfy the sound requirements laid down in that report for perfect (*i.e.*, inoffensive) refuse destruction and quoted above.

The utilisation of the waste heat of destructors for the generation of steam is rigidly limited by this consideration, that the efficient performance of its primary functions *as a destructor* shall not be impaired.

If the makers of destructors, in trying to fulfil the requirements of maximum steam production, impair (as Birmingham shows they will) the valuable qualities of the destructor—the results of 17 years' continuous improvement —it will be bad for them and bad for municipal electric lighting : they will, in all probability, convert an extremely valuable destructor into a combination of an inefficient destructor and a bad boiler : a knife is good, a corkscrew is good, both perfectly fulfilling their functions ; a combination knife and corkscrew means very generally a bad knife and a poor corkscrew, fulfilling perfectly the functions of neither. The safe line of progress lies in making the destructor as perfect as possible *as a destructor* (on the lines of the recommendations in the London County Council report), passing the gases, after they have performed their destructor functions, through a suitable boiler, and taking the result for what it is worth.

To put this in another way : The conditions for a perfect destructor are directly opposed to the conditions required for obtaining the maximum available calorific value of the burning refuse, and the medical officer of health, the public, and, as a last resort, the law will compel you to fulfil the conditions for perfect (*i.e.*, inoffensive) destruction of the refuse *first*.

Practical considerations of construction and maintenance will, of themselves, also tend to prevent any attempt to utilise the maximum heat. Of construction : if the boilers be placed above the furnaces, it will interfere seriously with the arrangement of the delivery platform for the refuse, for one thing, certainly raising it ; and as all the refuse has to be hauled to this platform up a grade, which will, in a city at any rate, be none too long, any increase in height is undesirable. If the boilers be placed between the furnaces in the side flues, the next best position (assuming, in accordance with best modern practice, that the exit for the gases from the furnace is at the side in front), then the side walls of the furnaces will be very much weakened, unless the brickwork, and therefore the space occupied, be much increased ; and one of the difficulties which has in certain cases occurred from the great heat obtained, is in the cracking of the brickwork. As to difficulties of maintenance, it is probable that the racking of the walls and lining of the furnaces and flues would be least when the temperature was kept most constantly at the same level ; boilers, however, will have to be periodically blown out, refilled and started again, and this, for the sake of the boiler, must be done slowly. If the boilers be placed on top of the furnace, I cannot see how this can be managed otherwise than by shutting down the cell and starting it slowly again, which will also tend to create a nuisance ; if the boilers be placed in the side flues, byepass flues might be arranged, but with difficulty, and only by considerably increasing the size of the top platform, and intensifying all the evils of expansion and contraction in the brickwork by still further dividing it up. When you place your boilers in your main flue, with suitable byepass flues, you avoid these difficulties, but at the expense of steam-producing power. I am not losing sight of the fact that as there is no Sunday collection of refuse, and if no accumulation of refuse, in the case of a destructor situated in a city, be sanctioned by the medical officer of health, a Sunday shut down of the furnaces may be necessary ; but in this case every endeavour will be made to keep up the temperature—not the reverse.

These are points upon which destructor builders and users are best entitled to offer an opinion ; they are here presented for consideration, and, if possible, to elicit an expression of that opinion.

Having now set out, as indispensable to the formation of any clear ideas on the subject, certain general conditions of the problem of the value of ashbin refuse utilisation, and certain practical considerations limiting the solution, I must, before presenting and analysing such recorded performances and promised results as I have been able to find, consider those other very important limiting conditions : the average amount of ashbin refuse per head of population per annum, and its calorific value.

These figures obviously must vary between very wide limits, depending upon the habits of the people, the climate, the season, the fuel used, the attention paid to the sanitary laws, the wealth of the population served, and even—and that very materially—upon so small a matter as the proportion of ashbins which are left open to the weather.

In a paper like this, not special but general, average figures must be adopted, and that round number which seems to me to most fairly represent the average yield of ashbin refuse per head per annum under good sanitary conditions, and in a water-closeted district, is 4 cwt. per head per annum—less, if anything.

When one finds, according to figures deduced from the returns given in the report to the L.C.C., already referred to, that this figure varies for the parishes included in the London sanitary districts from 1·7 cwt. per head per annum (Bermondsey), to 14 cwt. per head per annum (St. Luke's), it will be seen how carefully results based on an average figure (in this connection) must be checked even in applying it to districts in close proximity and under the same authority.

The figure I have given is the nearest round number to the average per head deduced from the report to the L.C.C. for 43 London sanitary districts, excluding the City, on account of its peculiarities as containing a very large day population (301,864), and a very small night population (37,000). The average for a population of 3,800,000 is 4·5 cwt. per head per annum. It is, however, obvious from the returns that other than ashbin refuse is included in certain cases, and it would have added to their value had the total refuse disposed of been subdivided.

This figure (4 cwt.) was also stated by Mr. Strachan as the figure for Chelsea, in the discussion on a paper by Mr. Santo Crimp, M.Inst.C.E. (*Proc.* Inst.C.E., Vol. 88).

Mr. C. H. Cooper, Assoc.M.Inst.C.E., has given me for Wimbledon 7,500 tons for a population of 27,500, *i.e.*, some-

thing over 5 cwt. per head; but he adds that in the summer a large quantity of garden rubbish is collected.

Prof. George Forbes, F.R.S., M.Inst.C.E. (Cantor Lectures, 1892), says at Paddington "every year they collected something like 20,000 tons of refuse of this character, and since the population of Paddington is 112,000, we may assume generally that something like this proportion exists in nearly all towns." This gives the figure 3·6 cwt. per head per annum.

It may be as well to state that neither Mr. Strachan's figure for Chelsea, nor Prof. Forbes's figure for Paddington, agrees with the figure deducible from the L.C.C. Report, which is 4·8 cwt. for Chelsea, and 6·3 cwt. for Paddington; this is, I suspect, due to the inclusion of more than ashbin refuse.

(To be continued.)

ELECTRICAL ENGINEERING AT THE WORLD'S FAIR.

[FROM OUR SPECIAL COMMISSIONER.]

III.

THE Brush Company's show is extensive, but contains few novelties. Their incandescent dynamo is built on the same lines as their well-known arc machine, the difference consisting in making the framework very much more massive, and one noticeable feature in this machine is the very thick armature, and the small segment of it covered by the pole pieces, the result is a small total induction, so that the E.M.F. is raised by employing a comparatively great number of turns of wire on the armature. Fig. 1 is a view of this dynamo.

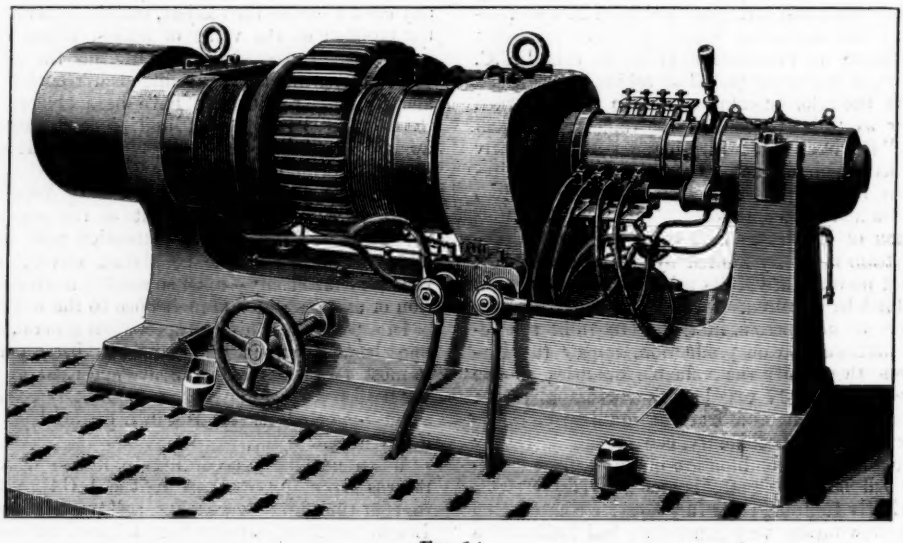
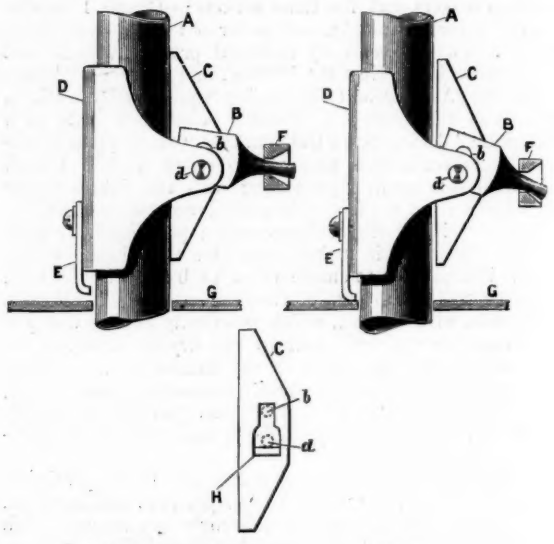


FIG. 1.

This machine has four brushes on each side. On close examination of the actual machines, it is found that the leading brush is always of carbon, while the others are the usual gauze or wire copper brush. It is well known that if one brush is fixed a little in advance of all the others, that one will spark, if sparking occurs at all, while the others will be relieved from sparking. In these Brush machines this is done, one brush made of carbon is fixed about half a commutator plate in advance of the others. This brush takes any sparking which may occur, and being carbon does not wear away the commutator. This device might be of advantage at some of the London central stations, where sparking at the commutators is always more or less to be seen.

The Brush Company have quite recently introduced a new arc lamp, or rather an improvement on their old one. In the old lamps the clutch was a simple thin washer, and on releasing the rod this allowed it to drop through freely; the speed of the drop was reduced by a glycerine dash-pot. In the new lamp the clutch is a long saddle-shaped slide, D, with a movable friction block, C, as in figs. 2 and 3; fig. 4



FIGS. 2 AND 3. FIG. 4.

shows the friction block. This form of clutch does not feed forward the carbon gradually, but step by step, and being a long clutch it is not affected to the same extent by the irregularities which may form on the rod during the use of the lamps. No dash-pot is required, as the action of this new clutch is slow and grips instantly the necessary feed has been made.

The following is the description given of the improvements. The same letters relate to the same parts in the different figures:—

A, represents the lamp rod.
B, represents the clutch lever.
C, represents the clutch shoe.
D, represents the clutch saddle.
E, represents the clutch trip.
F, represents an arm of the armature (which is moved up and down according to the strength of the spool magnets).
G, Represents the lamp bottom plate.
H, Represents a slotted rivet hole through C.
b and *d*, represent rivets.

Fig. 1 shows the clutch gripping the rod tightly. The armature arm, F, may move up and down, and will carry the

rod with it until the clutch trip, E, comes in contact with the bottom plate, G. As soon as this occurs, however, the downward movement of D is arrested, while F continues to descend, carrying with it B.

H is a slotted hole in C, made wider at the bottom than at the top. *b* is a rivet which runs through B and C at the top or narrow part of H. *d* is a rivet which runs through D, B and C at the lower or wide part of H. At this point in H there is a lateral play of $\frac{1}{16}$th of an inch. Now, when E strikes G so as to hold D stationary, F continues downward and swings C outward away from the rod A just so far as there is lateral play at its pivot *d*, which is $\frac{1}{16}$th of an inch. This allows the rod A to descend by its own gravity thus causing the carbons to approach each other. As will hereafter be clearly shown, the near approach of the positive and negative carbons by decreasing the electrical resistance renews the strength of the spool magnets and instantly F is drawn upwards which causes C to renew its hold on A, but at a point a little higher up. This operation is then renewed and continues until the carbons are consumed.

Prejudiced experts might attempt to pick flaws with this clutch and probably offer the objection that the slot, H, will clog with dust and dirt and render its action useless. This would be the case if the slot was the same size all the way down, but the play provided at that point by widening the slot entirely obviates any possibility of this trouble occurring. It cannot clog up or get out of order. C has such a long bearing on A, that although A may be enlarged in diameter by dirt and dust or lessened in diameter by dents, there will be enough points at which it will strike the rod that its action will always be quick and positive. This is a great advantage over any lamp which employs a clutch having a small gripping surface.

The Brush Company have an alternating system with transformers. Their alternators are on the same general plan of construction as the British Brush Company's alternators; the armature is built up of thin triangular coils formed into a disc and held in two metal rings, as shown in fig. 5, where one of the coils is shown between the two hand wheels, the field magnets revolve one-half on each side of the armature disc. The difference between this dynamo and Mordey's dynamo alternator lies only in the field magnets. In Mordey's machine the field is excited by one coil only, and all the N poles are on one side, while all the S poles are on the other side. In this American Brush alternator the poles on either side are alternately N and S, and each pole piece carries a coil; the pole pieces are wrought-iron screwed on to massive wheels each by two screws. The whole machine is well thought out and designed with much skill, while the workmanship is first-class.

Along with these exhibits are exhibits of Short's gearless electric car motors, and also Sperry's car motors, about both of which some interesting observations can be made when treating of electric tramways and railways.

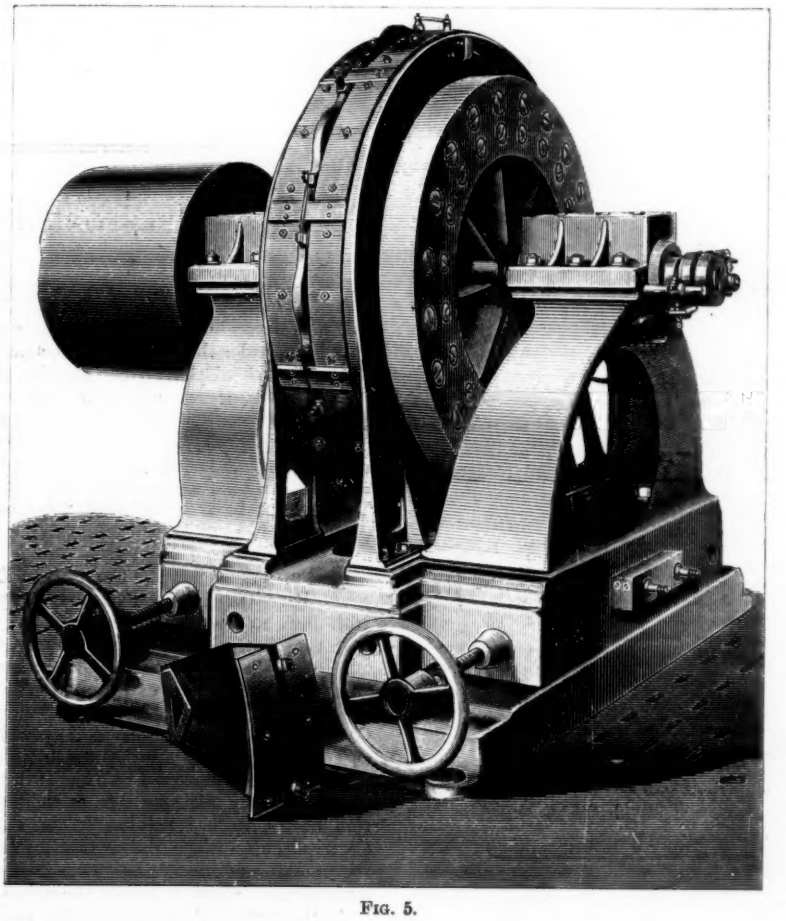


FIG. 5.

IV.

RAILWAY AND TRAMWAY MOTORS.

The exhibitors of these motors are Siemens, General Electric Company (Thomson-Houston and Edison Companies), Westinghouse, Short and Sperry.

The Siemens exhibit includes the small model electric locomotive shown at several former exhibitions, and the most interesting tramway motor in the exhibition. This is a three-phase motor of small size compared with all other railway motors shown of same power; it lies along the car at right angles to the axles to which it is geared by worm and pinion; its simplicity, compactness and fitness for the purpose are in great contrast to the ordinary continuous current motors. None of the cars are run inside the exhibition, except those of the Thomson-Houston (General Electric) on the intramural railway, so that no opinion can be given regarding the running powers of the various railway

motors. The absence of the commutator and brushes and the general simplicity of the three-phase motor go a long way to compensate for the extra conductor required to work it. The General Electric railway motor is a two-pole machine, ironclad type. The Short, Sperry, Brush and Westinghouse motors are four-pole machines all on the ironclad principle. It is very remarkable that all these railway motors are designed with very large armatures and weak fields. The American designs for ordinary stationary motors, as made by most makers, are built with strong fields and weak armatures, as theory and practice has long ago settled as correct; yet, when they come to design tramway or railway motors, we find the practice quite contrary to theory. The Sperry motors are the most noticeable in this respect; the armatures are very large and the fields very small. The Westinghouse motors come nearest theoretical proportions, they having well proportioned magnets with more iron in them. The General Electric Company's railway motors are next in order, the proportion of armature to field being greater than in the Westinghouse.

This strong armature and weak field must and does interfere with the action of these motors at starting; the strong armature reaction which would strengthen the field if there were enough iron in it is altogether lost, as the field magnets at the instant of starting must be far over ordinary magnetic saturation.

The greatest losses in the electrical railway motors occur in the frequent starting of the cars. At the start an immense current is required, in fact, just before the car moves at all the current is greatest; the work done is far from proportional to the expenditure of energy; and where several motors are on the same line, starting at the same time, the generators are timed to their very utmost, so that generators of very large capacity are now in general use—150 to 200 horse-power. If some gear could be used whereby the motors could be allowed to run on full speed while the cars were started slowly, an immense saving in energy and in first cost would result.

The Thomson-Houston people have adopted the Gennett air brake on their electric tramways; but, with the exception of Siemens's three-phase tramway motor, there is nothing new shown in electric or tramway motors.

Applications of motors to other purposes are numerous, but in few cases of any interest; one novelty to be seen at work is an electric cloth-cutting machine. In Leeds, Bradford and other large ready-made clothing centres, the cloth

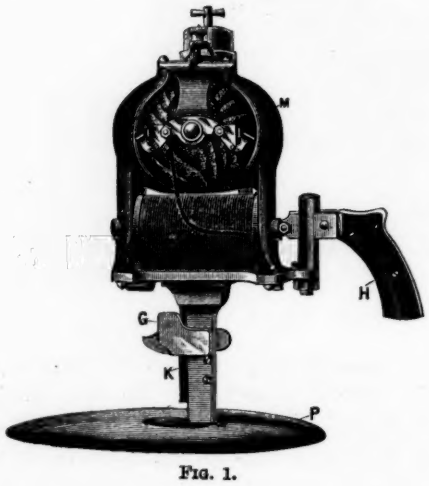


FIG. 1.

is usually cut out by band saws, a number of pieces being cut out at one time of one pattern by piling up layers of cloth several inches thick. Using a band-saw, the cloth requires to be fed into the saw, and, being rather difficult to handle, owing to its bulk, requires some skill to keep it in order. The Caldwell electric cutting machine, shown in fig. 1, is moved by a handle, H, through the cloth, which is laid out on a smooth table, the plate, P, passing under the cloth, keeps it up against ground plates, G. The knife, K, has an up and down motion of about two inches, and a to-and-fro motion of half-an-inch, producing the action of the hand-knife. There are two motors, side by side, with a crank between them to which the knife is attached by rods and levers; the speed of the motors is about 3,000, and when cutting through two inches of cloth they take about 4 ampères at 65 volts.

The machine is hung by a stout spiral spring from an overhead carriage, which can traverse the table in all directions. This overhead carriage runs on insulated rails, which serve also as conductors to supply the current.

Altogether this machine is much handier than the band-saw; it is much easier guiding the machine through the cloth than guiding the cloth into the saw. One machine can keep up with five markers marking out the patterns, and the cutter can follow the markers on the same table.

An electromotor is shown attached to a four-wheeled carriage through gearing, and is intended to be driven by accumulators. There are excellent roads just outside of where this carriage stands, where it might be shown to advantage at work. The exhibitor prefers to show it without running it, so that one cannot say how it does perform, but, judging from the gear wheels, their number, and evident roughness, it will doubtless make a good deal of noise in the world.

CORRESPONDENCE.

Electrical Sector of the Left Bank, Paris.

My attention has been called to a note in your issue of July 21st, under the heading "Electrical Sector of the Left Bank, Paris." Although the wording of this note is somewhat involved, it is sufficiently explicit to call for remark from me, especially as it is evident you have been misled by incorrect information. If you had yourself perused the official report of the discussion at the sitting of the Municipal Council on July 5th, to which you refer, you would certainly not have stated that "A discussion arose which was almost fatal to Mr. Naze, it having been suggested that he had failed."

As a matter of fact the Compagnie Electrique du Secteur de la Rive Gauche de Paris was fully constituted on May 16th last, in accordance with French law, which requires that the share capital shall be fully subscribed, and one quarter of the subscriptions paid in cash. There is, therefore, no question now of failure, as indeed the remarks of the president of the first commission of the Municipal Council sufficiently prove. I may add that the necessary authority for taking up the streets in order to lay the conducting cables was signed on June 29th last, contracts having been previously made for this, as well as for every other portion of the work, involving an installation of over 6,000 electrical horse-power, the contracting houses being amongst the most important in France, and comprising Messrs. Schneider, of Creusot, Messrs. Menier, Catin, Barrière, &c.

As the Secteur Company for the Left Bank has connections on your side of the Channel, I am sure, from a spirit of fairness, you will give the same publicity to the above corrections as to the note in question, which is the more calculated to mislead because framed in language which is obscure, and capable of conveying more than is doubtless intended.

E. L. Naze.

Electro-Cyanide Gold Extraction.

I should be very sorry, indeed, if my notes on the gold electro-cyanide process, invented by Mr. Hannay, were considered as an attempt to disparage it. It seemed to me that there were some points which it was important to elucidate, and if my criticisms are *refuted*, it will give still more value to this method of extracting gold by a combination of cyanide of potassium with electro-amalgamation.

There are several ways of treating refractory gold-bearing ores by cyanide of potassium.

The chemical process known and employed by metallurgists and electro-metallurgists for many years, in spite of its merits, is much below its repute.

The amalgamation in combination with cyanide, which, for one reason or the other has been adopted, abandoned, and is now again adopted, especially under the influence of the electric current.

To this classification must be added the electro-chlorine and cyanide process, and the electro-chemical system.

Which is the best?

Mr. Hannay, who had first used chlorine in conjunction with cyanide, now works an electro-amalgamating process. I know that it is difficult to avoid the attack of the copper by the cyanide solution. I raised some doubts, which the report of a chemist who has analysed a cyanide of potassium solution, after it has been dissolving the gold of certain pyrites without getting the copper in it, may dissipate at once.

Cyanide of potassium is a beast, the nature of which is to attack not only the noble metals but the base ones, and I shall be delighted to hear that Mr. Hannay has tamed or muzzled it.

I will not hazard a criticism on the use of mercury, but my experience is, that it is much better to dispense with it.

If the quantity of ore to treat is great, the mass is heavy and the quantity of mercury large; the ore will press on the mercury and break it up. This is a law of nature. I may be mistaken, and if the mercury after treatment of a few tons of ore does weigh as much as before, this will be a victorious argument to my criticisms.

There is another question to consider, the everlasting property of cyanide to be used *over and over again*. This recovery of cyanide of potassium would be more wonderful than the recovery of 1 ounce and 1 pennyweight of an ore which contains 1 ounce of gold only. There are several causes of loss when using cyanide of potassium. I am quite willing to concede that there is no loss of cyanide of potassium at all, but in the mean time I want to know how and why a loss can be avoided in the complicated and very little known decomposition of cyanide by electricity with formation of cyanates, carbonates, &c.? Cyanide of potassium, if applied in a merely chemical process, does not act uniformly as a solvent of gold on all sorts of auriferous ores. On the contrary it fails, in some cases, to dissolve more than half of the gold associated with the minerals, and its dissolving action ceases long before its solution is nearly saturated with gold. Much more satisfactory results are obtained when, instead of a chemical solution of cyanide of potassium, an electrolysed solution of cyanide of potassium is used, which yields its gold to mercury, and in the present case is alternately changed into a gold cyanide and decomposed into a simple cyanide solution. Under the influence of the electric current, the solution splits up into potassium at the negative pole, and cyanogen which is freed at the positive pole and in its nascent state, develops a greater energy than would the cyanide solution itself without current for dissolving the gold present in the finely powdered ore, agitated and kept in suspension in the electrolyte. In this manner the whole of the solution and the mass of the ore is influenced by the electric current, and there is a thorough and constant exposure of every particle of the ore to the electro-chemical action. There is no trace of gold which can possibly escape or resist the dissolving properties of the electrolytic cyanide; but there is a limit to these dissolving properties of cyanide, and, unfortunately, the solution is soon weakened, and then wants strengthening by an addition of cyanide of potassium.

The Writer of the Article.

Market wanted for Mica.

A correspondent of ours abroad has discovered a seam or bed of mica on his property, and purposes consigning a quantity.

Will you, or any reader, inform us through the ELECTRICAL REVIEW, where a market can be found for this article?

Mica.

THE CRITICAL CURRENT DENSITY FOR COPPER DEPOSITION AND THE ABSOLUTE VELOCITY OF MIGRATION OF COPPER IONS.

BY SAMUEL SHELDON AND G. M. DOWNING.*

IT is a well-known fact that, in the electro-deposition of copper from solutions of its salts, if with a given exposed surface of cathode a certain current strength be exceeded, the deposit assumes a chocolate brown colour when the solution is concentrated, or a dead black colour when the solution is dilute. It is often stated that this modified form of deposit is but copper in a finely divided state. Magnus,† however, long ago stated that it was hydride of copper. He assumed that, for some reason or other, after a certain *critical current density* was reached, either the water of solution or H_2SO_4, formed by the union of liberated SO_4 with the water, took part in the conduction near the cathode. He endeavoured to measure this current density by varying the current which was passing through an electrolytic cell containing $CuSO_4$, and then noting the strength at the moment when the hydrogen bubbles began to appear at the cathode. His results were not very concordant. C. L. Weber‡ explained the appearance of the copper hydride as follows: as the current which is passing through a certain copper solution with definite sized electrodes increases, the rate of deposit increases, and as a result, the rate of abstraction of copper from the portion of the solution around the cathode. Inasmuch as the copper ions have a definite absolute velocity, this rate of deposit is limited. If the current strength demands a greater deposit, the SO_4 ions, at the moment of electrolytic severance from the copper, join with the water, form H_2SO_4, and this takes part in the conduction, depositing hydrogen alongside of the copper. Weber endeavoured to measure the absolute ionic velocity of the copper ions. He passed a current through a variable resistance, a galvanometer, and a solution contained in a glass tube. The electrodes were pieces of copper, ground to fit the ends of the tube. The potential difference between the electrodes was measured by means of a high resistance galvanometer. The current was increased by steps, and closed for 15 seconds. The galvanometer deflections were read just before the one of high resistance indicated a sudden rise in the potential difference, owing to the polarisation resulting from the newly deposited hydrogen. It is not necessary to give his method of calculating the ionic velocities, for it is analogous to the one to be explained later. His results were not wholly satisfactory, errors of 10 per cent. being admitted.

The present investigation considers the causes which affect the critical current density for copper sulphate solutions, and includes a determination of the absolute velocities of migration of the copper ions in solutions of varying concentration.

Apparatus.—The current was taken from the Edison street mains at 115 volts, and its strength was regulated by a bank of lamps. The current was measured by a Weston 0—5 ampère ammeter. The potential differences were measured by a Weston 0—150 volts voltmeter, whose series high resistance coil was short-circuited. A resistance of 314 ohms was inserted in the voltmeter circuit, causing the pointer to deflect the whole 150 scale divisions for 3 volts. The electrolyte was contained in a glass vessel of shape indicated in fig. 1. The anode was a hollow copper cylinder of 4 cms. internal diameter. The cathode was a copper-plated brass rod, of ·648 cm. diameter. This was fastened into the centre of a wooden cover, grooved to fit exactly over the top of the glass vessel.

Method.—The solution to be investigated was placed in the vessel and a current of somewhat less than the critical strength was sent through. This produced the normal copper deposit. The stopcock at the bottom of the vessel was then opened, and as the electrolyte ran out, the cathode surface diminished. Inasmuch as the resistance offered by the electrolyte was very small compared to that of the whole circuit, there was very little alteration in the current strength

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* From an American exchange.

† Magnus, *Pogg. Ann.*, 112, p. 23, 1857.

‡ *Ztschr. f. Phys. Chem.*, 4, pp. 182—188, 1889.

during the flow. Accordingly, after a certain amount of the electrolyte had flowed out, the surface of the cathode was reduced so as to produce the critical current density. The deposit immediately assumed the dark colour, and upon removal of the cathode, the area could be readily measured by means of a micrometer gauge and a scale. The line separating the reguline deposit from the dark coloured one was very distinct, especially when produced from a

FIG. 1.

moderately dilute solution. In all cases its position could be determined within ·3 mm. The current was generally adjusted so that the height of the dark deposit was about 125 mm.

Influence of Rapidity of Flow.—Inasmuch as the appearance of the dark deposit is intimately associated with the alteration in density of the solution near the cathode, it is evident that the flow, upon turning the stopcock, must be so regulated as not to disturb the solution at this place. The form of apparatus was a happy one in this respect. This was proved by the following observations: A large quantity of $CuSO_4$ solution was prepared; portions of this were allowed to run, in succession, through the vessel at different rates. The current strengths (in ampères) divided by the areas (in square cms.) covered by the black deposit, *i.e.*, the *critical current densities*, D, are given in the following table, opposite to the times required to flow out of the vessel. The values of D are corrected for slight differences of temperature.

An inspection of this table shows that if the time which it takes the electrolyte to flow out of the vessel be greater than 8 or 9 minutes, the values of D will be practically the same as those which would be obtained were the electrolyte at rest.

TIME.	$D_{22°}$.
Min. Sec.	
0 23	0·0886
0 34	0·0581
1 0	0·0455
1 30	0·0405
2 16	0·0375
3 3	0·0361
5 0	0·0342
8 49	0·0334
15 0	0·0330
20 0	0·0332

Influence of Temperature.— As might be expected, temperature has a great influence upon the value of the critical current density. Theory would indicate that the temperature coefficient should be the same as that for the specific conductivity of the solutions. Kohlrausch's* values referred to the conductivity at 18° are from ·021 to ·024; *i.e.*, the specific conductivity at 18° increases for each degree rise of temperature from 2·1 to 2·4 per cent. according to concentration.

We have failed to obtain coefficients as small as these, ours ranging from ·031 to ·038. Our method of determination was to fill several glass-stoppered flasks with a solution taken from a stock bottle which had been previously shaken. These flasks were placed in water baths and brought to various temperatures, suffering no evaporation in the process. These solutions were successively placed in the density vessel, and as soon as the dark deposit appeared the temperature was taken. It seems hardly possible that the values given above are far from correct.

Influence of Concentration.—The critical current density increases with the concentration. We have investigated solutions containing 2, 1, ·5, and ·1 gram equivalents to the litre of solution. (A gram equivalent solution of $CuSO_4$ contains 31·55 grams of copper in a litre of the solution.) During preliminary observations the most concentrated solution became somewhat impoverished of copper. Not all of the anions set free by the current were able to unite with the anode. Accordingly, after the final determinations, the specific gravity of the solution was obtained. This was also done with the other solutions. By means of tables * and the value given by Kohlrausch † for the specific gravity of a normal solution (1·0775 at 18·2°) we were enabled to determine the concentration.

Our results are given in the following table, where m represents the gram equivalents to the litre of solution, and D the current density in ampères per square centimetre. The values are reduced to 19°.

m	$D_{19°}$	D_{19}/m
1·89	0·1005	0·0532
1·	0·0528	0·0623
0·5	0·0257	0·0514
0·1	0·00542	0·0542

If the method of observation were susceptible of greater accuracy, it would undoubtedly be found that the values of D_{19}/m would increase with dilution in the same manner as the values of the specific molecular conductivity.‡

For industrial or experimental purposes an approximation formula for determining the critical current density when the specific gravity of the solution is known may be of value. The excess of the specific gravity of solutions at 18° C. above ·9987 (the density of water at 18°) is very nearly proportional to the percentage of salt contained. Accordingly, if we represent the specific gravity of the solution by d, the critical current density in ampères per square centimetre of cathode surface

$$D_{18} = (d - ·9987)\ ·65$$

within a few per cent. This is the limiting current allowable when the solution is at rest. By means of circulation at *the cathode surface* this value may be increased many times.

Velocity of the Copper Ions.—If the assumption be made that the cause of the abnormal hydride of copper deposit is the inability of the copper ions to migrate fast enough to keep up the supply for deposit, which is required by Faraday's law, the velocity of migration can be determined in the following manner. Suppose that a current of C ampères is the critical current for a deposit upon q square centimetres of cathode surface from a solution of m gram equivalents to the litre. Consider a layer of the solution around the cathode, of radial thickness $d\ r_1$. This layer contains $31·55\ m\ q\ d\ r_1$ milligrams of copper. The current requires that, in the short time $d\ t$, $·3281\ C\ d\ t$ milligrams be deposited. If we suppose $d\ r_1$ to be of such a size that $31·55\ m\ q\ d\ r_1 = ·3281\ C\ d\ t$, and remember that C is of such a magnitude that the ions migrate with exactly the requisite velocity to maintain the reguline character of the deposit, it will be evident that all the copper ions in the elementary

* F. Kohlrausch, *Wied. Ann.*, 6, 1 and 145, 1879.

* Landholdt und Börnstein, *Tabellen*, p. 147.
† F. Kohlrausch, *Wiedemann's Ann.*, Bd. xxvi., p. 174, 1885.
‡ F. Kohlrausch, l.c., p. 196.

layer considered have migrated to the cathode in the time, $d\,t$, and their velocity has been

$$v = \frac{d\,r_1}{d\,t} = \frac{\cdot 3281\ c}{31{\cdot}55\ m\,q}. \qquad (1)$$

If the current were less than the critical amount, c, the velocity would be smaller, as would also be the drop in potential along $d\,r_1$. In all cases when the current is less than c, the velocity is directly proportional to the drop in potential. The velocity in absolute measure must be expressed as so many centimetres per second under an impressed difference of potential of 1 volt per centimetre, measured along a line of current flow.* Let $d\,E$ represent the volts of potential difference between the concentric surfaces enclosing the layer of thickness, $d\,r_1$. Then the velocity of the copper ions in absolute measure,

$$v_0 = \frac{v}{\frac{d\,E}{d\,r_1}} = \frac{\cdot 3281\ c\ d\,r_1}{31{\cdot}55\ m\ q\ d\,E}. \qquad (2)$$

Consider a single observation with the arrangement of apparatus which we have employed. Let

E = volts between electrodes,
r_1 = radius of cathode,
r_2 = radius of anode,
R = resistance of solution,
s = the specific resistance of the solution,
h = height of solution.

We have $E = c\,R$

and $$d\,E = c\,d\,R. \qquad (3)$$

The resistance of an elementary hollow cylinder of the solution of radius r is

$$d\,R = \frac{s\,d\,r}{2\,\pi\,h\,r}. \qquad (4)$$

Substituting this value in (3), we have

$$\frac{d\,E}{d\,r} = c\,\frac{s}{2\,\pi\,h\,r}. \qquad (5)$$

If we consider $r = r_1$, we can substitute by merely adding the subscript to r in equation (2). But this expression is not in a convenient form for introduction into the expression for v_0, for it involves the value of the specific resistance of the solution. The formula can be altered so as to eliminate s, but it should be borne in mind that any lack of homogeneity in the solution during an observation, affecting s as it does, affects the validity of the application of the modified formula to the observations. By applying Ohm's law and integrating (4), we obtain

$$R = \frac{E}{c} = \int_{r_1}^{r_2} \frac{s\,d\,r}{2\,\pi\,h\,r} = \frac{s}{2\,\pi\,h}\ \log.\ \left(\frac{r_2}{r_1}\right). \qquad (6)$$

$$\therefore\ \frac{s}{2\,\pi\,h} = \frac{E}{c\ \log.\ (r_2/r_1)}. \qquad (7)$$

Substituting this value in (5) and again in (2), we have

$$v_0 = \frac{\cdot 3281\ c\ r_1\ \log.\ (r_2/r_1)}{31{\cdot}55\ m\ q\ E}. \qquad (8)$$

In our experiments $r_1 = \cdot 324$ cm. and $r_2 = 2$ cm. Hence the formula reduces to

$$v_0 = \cdot 006136\ \frac{c}{q\ m\ E}.$$

The results which we have obtained are tabulated below, where m represents, as before, the gram equivalents to the litre of the $CuSO_4$ solutions.

m.	c	q	E	v_0
1·89	2·59	25·16	1·55	0·000204
1	1·35	25·56	1·26	0·000257
0·5	0·732	28·32	1·03	0·000308
0·1	0·128	22·78	0·775	0·000445

It is very probable that these values of v_0 are too large, owing to an increase in the specific resistance of the solution around the cathode, which follows the closing of the circuit. To eliminate this error as far as possible, in every observation the auxiliary resistances in circuit were so adjusted that the current, upon closing the circuit, was slightly less than the critical current for the exposed cathode surface. The surface was then decreased by allowing the fluid to flow out at the bottom of the vessel. The appearance of the abnormal deposit, indicated by a sudden rise in the voltage, followed the closing of the circuit in less than a minute.

The values given by Weber are less than the ones obtained by us. His method, too, involves the specific resistance, and is open to the same criticisms as ours.

Polytechnic Institute of Brooklyn,
March, 1893.

* It must be remembered that the expression for the velocity of certain ions does not imply that all the individual ions migrate with that velocity, but that it is the expression for the mean value of their velocities.

NOTES.

The Faure Patent.—The decision was given on the 18th inst., by Judge Coxe, in the U.S. Circuit Court for the Southern District of New York, in the case of the Electrical Accumulator Company *v.* the Julien Electric Company, declaring the famous Faure patent to have lapsed and expired, by reason of the prior expiry of the Faure Spanish patent for the same invention. This decision is the outcome of the long and protracted litigation between the parties now representing the Consolidated Electric Storage Company, on the one hand, and the parties representing the Accumulator Company, successors of the Electrical Accumulator Company, on the other hand. The contest has been maintained with unabated vigour for nearly seven years. At first, the victory seemed to be on the side of the Electrical Accumulator Company, who obtained an injunction against the defendants on April 12th, 1889, compelling the stoppage of the electric cars on Fourth Avenue. Then the defendants got control of the Brush Storage Battery patents, and joining in the Brush suit, vigorously attacked the complainants, defeating them; but the complainants maintained that it was but half a victory, for the reason that without the aid of the Faure process—"paint, paste and cement"—the defendants could not make a practical storage battery, although possessed of the Brush Storage Battery patents—the fundamental patents; in other words, the complainants contended that the active matter or layer must, to be successful, be applied in the form of a paste, and not in the form of a powder, as practised by the defendants. Late in 1890 the defendants became aware that the Faure Spanish patent would expire the following year. Steps were immediately taken to secure the proper documents from Madrid. The formalities to be observed in doing this were numerous and difficult to follow. However, after many disheartening set-backs and untold obstacles, the defendants succeeded in getting a complete record of the papers at Madrid, and had a rehearing in the case, with the result that the patent was declared to have expired. The situation now is, that although "paint, paste and cement," as such, is no longer patented, yet it is not open to public use, for the reason that its application to the plate or support is covered by the fundamental Brush patents, of which this company is the exclusive licensee. As a matter of fact, the process is now owned by the Consolidated Electric Storage Company instead of by the Accumulator Company, as fully as if the Faure patent were still alive and owned by the Consolidated Electric Storage Company—as if there had been a transfer from the Accumulator Company to the Consolidated Electric Storage Company. Thus, by operation of law, the Faure process hitherto owned by the Accumulator Company has become the property of the Consolidated Electric Storage Company.

Owens College, Manchester.—The prize for the best essay on the Technical Applications of Electricity, has been awarded to Mr. J. R. Ashworth. This prize, of the value of £10, was given in the present year by Dr. Edward Hopkinson, the subject of the essay being "The Testing of the Efficiency of Dynamos and Motors."

Blackpool Electric Tramways.—The Blackpool, St. Annes, and Lytham Tramways Bill, which authorises the extension of the system of electric tramways from Blackpool to St. Annes and Lytham, was on 28th inst. before the Chairman of Committees in the House of Lords as an unopposed measure. The Bill was reported to the House for the third reading.

Electrocution.—Telegrams in the daily papers last Friday recorded an account of a shocking scene witnessed in the gaol at Auburn (N.Y.), on the morning of the 27th ult., when an attempt to kill a man named Taylor by electricity was unsuccessful. He had murdered a fellow convict in September last; after he had been placed in the chair and the electric current applied, the foot-rest broke, and the dynamo became exhausted (*sic*), so that a second shock could not be applied. Taylor shortly began to breathe heavily, and was at once removed to his cell and placed in his bed, where he continued groaning. The physician states that Taylor became unconscious after the first shock, which was equal to 1,709 volts, and that his condition after being taken from the chair was like that of a person suffering from a stroke of apoplexy. Morphine was administered to him, and at five minutes to two in the afternoon Taylor was again carried to the chair, when the current from the city electric light dynamo was passed through his body, instantly killing him.

The "Lancet" and Lead Poisoning.—Referring to the recent suggestion, in the *Lancet*, that the voltage between gas and water pipes may produce electrolytic effects whereby traces of lead might find their way, in solution, to the water, the New York *Electrical World* points out that, in the first place, the lead is not "dissolved" by such an electrolytic action unless the earth contains a *solvent* of lead, in which case the dissolution would occur even if there were *no* current. In the second place, this current passes from one pipe to the other through the earth, and therefore affects only the external surface of the pipes, and not the internal, except, possibly, to a very slight degree through high resistance water circuits of small cross section, back through the reservoir and the pumps to the ground, the water in the pipes being connected directly to the earth only in the case of leak. Lastly, they point out that the electrolytic action between iron and lead, in an electrolyte, is to oxidise the iron, and not the lead—the latter being reduced—which renders it all the more insoluble. Alarm is expressed that such questionable doctrines should be set forth by the unimpeachable, never-erring *Lancet*.

Researches on the Colour Phenomena of the Ions.—W. Ostwald is pursuing the interesting line of research which has for its objection the investigation of colour phenomena amongst the ions. Experience regarding absorption phenomena of undissociated compounds in solution, shows substitution in the molecule to effect distinct alteration in the light, absorption and colour. Ostwald has recently found that in a salt solution of finite concentration, the absorption spectrum of the electrically neutral molecules that are present, together with that of each of the ions, constitutes that of the solution. At high dilutions, when the dissociation is quite complete, all salts with the same coloured ion must have the same absorption-spectrum and colour, if the other ion be colourless. Krüss (*Zeit. Phys. Chem.*, ii., p. 320) and Knoblanch (*Ann. der Phys. Wied.*, lxiii., p. 767) have made opposite statements to this; but to prove their error, Ostwald has measured and photographed the absorption-spectra of about 300 salts. These data (*vide Zeits. Physik. Chem.*, ix., p. 579) show conclusively that the spectra of dilute solutions of different salts, with the same coloured ion, are identical. It is interesting to note that these conclusions are in accord with the result arrived at by Ewan (*vide Phil. Mag.*, xxxiii., p. 317) in an investigation of some solutions of copper salts. In connection with this subject, it may be remembered that Vogel (*Ann. der Phys. Wied.*, xliii., p. 449) emphasises the influence of the *position* of the substituents in a charged molecule, whilst Schütze (*Zeits. Phys. Chem.*, ix., p. 109) lays stress upon the relation between constitution and colour. Some results by C. Grebe (*Zeits. Phys. Chem.*, x., p. 673) appear to show that the position of the substituents has an entirely regular influence.

Manchester Electric Lighting.—The new electric lighting works of the Manchester Corporation were brought into public use for the first time on Monday evening last. The formal opening of the works was on Tuesday.

Electric Traction on the Continent.—It is intended to connect Elberfeld with Cronenberg-Müngsten by means of an electric tramway, and also to form a connection with the electric line recently started at Remscheid. Baron von der Heydt, who has been consulting the local authorities on the matter, has undertaken to finance the enterprise, which it has been decided to carry out.

The Essen Tramway.—As mentioned in a previous issue, it is intended to set the electric tramway, now constructed, in operation on the 15th inst. The power station and depôt are situated near the Viehofer Chausseé, and the latter already contains 20 new cars, each capable of accommodating 30 persons. The plant comprises 3 Steinmuller water-tube boilers, 2 large Kollmann steam engines, and 4 dynamos, made by the General Electricity Company, of Berlin.

Purification of Sugar.—The N.Y. *Electrical World* mentions a process in which a current is passed for a few minutes through the warm liquor between electrodes of zinc; a heavy, muddy precipitate is formed on the positive electrode. The current produces a coagulation of the albuminoids, which hold all the other material in suspension. The oxide of zinc combines with the various organic substances. The precipitate contains one-third oxide of zinc, but no zinc is found in the resulting sugar solution.

The Remscheid Tramway.—The traffic on the electric tramway, which was started only last month, has so largely increased, that the present means of dealing with it have proved inadequate. There are already laid down 2 dynamos and 2 boilers and engines, and of the 7 cars four are in operation. It is now found necessary to increase this number to 12 cars, and to instal another dynamo and engine and boiler. An extension of the line is to be made, and two-fifths of the additional capital necessary will be taken up by the town.

Electric Lighting Libel Case.—The heated discussions that took place some months ago at Heckmondwike, when the electric lighting question was under consideration, will be well remembered by our readers. Mr. Wm. B. Hutchinson, an electrical engineer, of Liversedge, who at the time had reported at the request of the Local Board, regarding electric lighting, has just won a libel case which he had taken out against a member of the Local Board, who in the course of the discussions said that Mr. Hutchinson was neither "honest, truthful, or industrious."

Jury of Awards at Chicago.—The list of judges in the electrical classes at Chicago has now been prepared. For America they are as follows:—H. S. Carhart, B. F. Thomas, T. C. Mendenhall, M. O'Dea, S. Reber, C. E. Emery, H. J. Ryan, G. F. Barker, R. B. Owens, W. M. Stine, H. A. Rowland, and E. P. Warner; all of these gentlemen, it seems, are well qualified for the tasks appointed them. The English judges are Profs. Ayrton and Geo. Forbes. The German judges are Director Rathman and Baurath Ulbrecht, and Belgium has nominated M. Pierre Dehousse. France, Russia, Austria, and Sweden have not yet appointed their jurors.

A Curiosity.—A correspondent writes to us concerning a 200 C.P. Swan lamp made of green glass for a ship's side light, which has been destroyed by the focussing of heat rays upon it by the reflector placed behind it. The heat has been so intense that the glass was softened, and the vacuum drew it in like the "kick" of a bottle, until the glass was perforated and the carbon consumed. He has another lamp drawn in also, but not perforated, the filament remaining intact. Both were softened on the side next the reflector, so that it is evident that the filament did not touch the glass, but that the mischief was done by the concentration of heat in the focus of the mirror. The green is very dark in the glass, and absorbs a lot of heat.

Visit to Dundee Electric Light Station.—The members of the North British Association of Gas Managers, on 27th inst., visited the electric light station at Dudhope Crescent Road, and inspected the various departments.

Bolton Electric Lighting.—A Local Government Board inquiry was held on August 3rd, into an application by the Corporation for sanction to borrow £40,000 for the purposes of electric lighting.

City and Guilds of London Institute.—At a meeting of the Council, held on July 31st, the diploma of "Associate of the City and Guilds Institute" was awarded to the following third-year students of the City and Guilds Central Institution:—Civil and Mechanical Engineering: K. W. Digby, G. A. Fry, G. H. Heelas, R. F. Krall, H. F. Robinson, A. E. H. Sonneborn, C. V. Drysdale, T. L. D. Hadwen, E. L. Joselin, H. C. Leake, R. D. T. Roe, and W. T. W. Sussman. Physics and Electrical Engineering: G. H. Ballie, W. A. Brodie, W. Casson, J. R. Dick, A. H. Finlay, E. E. Gunter, W. E. Miller, J. Barnard, R. B. Burrowes, W. R. Cooper, W. H. Everett, E. G. Fleming, T. Hemmant, N. Ward, and C. H. C. Woodhouse. Applied Chemistry: O. F. Russell.

The Government and the Telephones.—In the House of Commons the other day, Mr. H. Foster asked the Postmaster-General whether an agreement was now being settled between the Post Office and the National Telephone Company for the purchase by the Post Office of the National Company's trunk wires, or for the settlement of other matters; and, if so, would he lay a copy of the proposed agreement upon the table of the House before it was signed. Mr. A. Morley said the agreement with the National Telephone Company of 1892 with the Treasury minute of that year was in the course of settlement, and, in pursuance of the recommendations of the Select Committee, the agreement would be laid before Parliament; but the Committee was of opinion that the responsibility for the details rested with the Government, and he did not propose to lay it on the table before it was signed. The agreement would be on the lines of the minute.

Fire Caused by Lightning at Leatherhead.—A correspondent writes to us regarding a fire which occurred on Wednesday last week, through an electric discharge during a thunderstorm, and he thinks some valuable information might be elicited regarding it. The mansion (Cherkley Court) at which the fire occurred, our correspondent believes, was fitted with electric light in about 1887 by the Electrical Power Storage Company; he was present at the house about three years ago, and admired the excellent effect produced. The supply, so he thinks, was by aerial leads about 200 yards distant. Probably the current would be off at the the hour the fire occurred, but it would be advantageous to know if the fire originated near the entrance of the leads. He believes a lightning conductor was fixed on the highest part of the mansion, and it would be interesting to learn if this was properly earthed. Possibly further information may be forthcoming from some of our readers on this subject.

The Proposed Cable between Australia and Canada.—A Reuter's telegram from Sydney, on 30th inst., reads as follows:—"The laying of the Queensland and New Caledonia telegraph cable, which will form the first section of the projected cable between Australia and Canada, will shortly be commenced, and is expected to be finished by the end of August. The laying of the continuation to Vancouver will probably be completed within two years." The makers and layers of this cable are the Société Française des Téléphones, and the line is subsidised by the French and New South Wales Governments. The steamship *François Arago* (late *Westmeath*) is laying the cable. It is not thought over here that this cable will ever form a link of a Pacific cable from an Imperial standpoint. New Caledonia being a French island will be an objection to this. If England should take possession of New Caledonia by arrangement or otherwise, then this new cable may become a link in the Imperial chain of communication between Australia and Canada. The cable was manufactured at the Calais works of the above Société.

Sunderland Gasworks Extension.—The gas company are extending their works and appliances, involving an outlay of £20,000.

Workhouse Lighting.—After further consideration it has been decided to light Worcester workhouse by gas instead of electricity as was proposed.

The Institution of Electrical Engineers.—Among the papers to be read during the next session will be one on "The Electrical Transmission and Distribution of Power at Niagara Falls," by Prof. George Forbes, F.R.S., member. A paper upon "The Electric Lighting of the City of London," has also been promised by Sir David Salomons, Bart., Vice-President.

Chestnuts.—The *Pall Mall Gazette's* special correspondent has suddenly discovered that two men were some weeks ago killed in Rome by the electric light current of one of the lamps in the Piazza of the Quirinal. This was published in the ELECTRICAL REVIEW for July 14th. Our contemporary publishes the note in Tuesday's issue as though it were fresh information.

NEW COMPANIES REGISTERED.

Incandescent Electric Lamp Company, Limited.—This company was registered on the 25th inst., with a capital of £25,000, in £10 shares, to carry on either in Great Britain, Ireland, or abroad, the business of manufacturers of, and dealers in, electric light lamps, fittings, appliances, and materials; and to carry on in every way the business of an electric light company. The subscribers are:—G. Binswanger, 71, Queen Victoria Street, E.C., manufacturer, 100 shares; H. Hirst, 71, Queen Victoria Street, E.C., electrical engineer, 10 shares; A. W. Boyce, 18, Inverness Terrace, W., retired colonel, 60 shares; J. F. Gregarthya, Eton Avenue, N.W., chartered accountant, 100 shares; G. R. F. Fraser, Hampton Wick, chartered accountant, 10 shares; J. Fraser, jun., 81, Carleton Road, chartered accountant, 10 shares; J. W. S. Dower, 17, Park Square East, N.W., gentleman, 50 shares; E. Hove, 1, Lowndes Square, W., 10 shares; T. H. Riches, Telverton, South Devon, gentleman, 100 shares. The number of directors is never to be less than three nor more than seven, the first being J. Fraser, G. Binswanger, and C. J. Robertson. Qualification, £500; remuneration to be voted in general meeting. Registered by James Fraser & Sons, 31, Copthall Avenue, E.C.

Frank W. Clark & Co., Limited.—This company was registered on the 26th ult. with a capital of £10,000, in £1 shares; to acquire an invention for certain improvements relating to the distillation and breaking up of liquid hydrocarbons, and similar substances, and to apparatus therefor; to enter into an agreement for that purpose, to supply, sell, and distribute gas and electricity for any purpose, and to manufacture any article which may be used in connection with this. The subscribers (with one share each) are: F. Murray, 16, Birchin Lane, S.W., solicitor; C. Steele, Battersea Park, S.W., shorthand writer; H. P. Landon, 53, New Broad Street, E.C., solicitor; H. C. D. Nettleton, 4, Westeria Road, Lee, secretary; J. McDonald, 43, Threadneedle Street, E.C., Australian agent; F. W. Clark, South Norwood Hill, S.E., engineer: A. C. Trotman, 49, Gribyon Avenue, Herne Hill, clerk. Registered without articles of association by E. F. & H. Landon, 53, New Broad Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

London Battery Company, Limited.—The annual return of this concern has been filed recently. Out of a capital of £10,000, in £5 shares, 998 have been taken up, with the full amount paid on 304, and £2 10s. on 80 others. The total sum of calls received equals £1,720; and £3,070 has been considered as paid on 614 shares.

Phonopore Company, Limited.—The annual return of this company was made at Somerset House a short time ago, and shows that out of a capital of £150,000 in 100,000 ordinary and 50,000 preference shares of £1 each, that 90,000 ordinary and 28,063 preference shares have been taken up. There has been a sum of £1 called on each of 20,975 ordinary shares, and 10s. on 17,683 preference. The total amount received is £30,218; £79,405 has been agreed to be considered as paid, and £8,440 remains in arrear.

Easton & Anderson, Limited.—The annual return of this company shows that out of a capital of £250,000, in 2,060 ordinary 440 5 per cent. preference shares of £100 each, the whole of the former class, and 184 of the latter, have been taken up. A sum of £100 has been called on 184 of the preference shares, and £206,000 has been considered as paid on the ordinary shares. The total amount of calls received reaches £18,400.

Eastbourne Electric Light Company, Limited.—The annual return of this company was filed on May 19th, and shows that out of a capital of £50,000, in £10 shares, 1,017 ordinary and 40 preference have been taken up. The whole amount has been called, and the total sum of calls received reaches £10,570.

Evered & Co., Limited.—The annual return of this company has just been filed, and shows that out of a capital of £200,000 in £10 shares, 16,496 have been taken up. There has been a sum of £10 called on 6,744 of these shares, and £7 on the remaining 9,752. The total amount of calls received equals £135,704.

New Telephone Company, Limited.—From the annual return of this concern, lately filed at Somerset House, it appears that out of a capital of £750,000, in 74,700 £10, and 3,000 £1 shares, 74,695 of the former, and the whole of the latter, have been taken up. There has been called up on 1,000 shares a sum of £10,000, £292,800 on 73,200, and £3,000 on the 3,000 shares before mentioned. The total payment received is £304,736. There is an amount of £5,000 agreed to be considered as paid, and £1,064 is still unpaid. Five shares have been forfeited, the total value of these being £10.

Provincial Electric Light and Power Supply Company, Limited.—From a letter signed by Mr. V. B. D. Cooper, dated June 19th, 1893, now filed at Somerset House, it appears that "the undertaking has been abandoned upwards of six months."

CONTRACTS OPEN AND CLOSED.

OPEN.

Cheshunt.—August 7th. Lighting of public streets by gas, oil, or otherwise, for the Cheshunt Local Board.

Gateshead.—August 12th. The Gateshead Industrial Co-operative Society, Limited, Jackson Street, Gateshead-on-Tyne, are prepared to receive tenders from electric light engineers for a complete installation of the electric light for their Jackson Street premises.

York.—August 15th. For wiring for the electric lighting of the institute, Clifford Street, for the Technical Instruction Committee. Specification, schedule, form of tender, and plan may be obtained from Mr. A. Creer, A.M.I.C.E., city engineer, Guildhall, York.

CLOSED.

Bolton.—The tender of Messrs. Hick, Hargreaves & Co., for the supply of the steam boilers required for the electricity station, has been accepted. The Electricity Sub-committee inspected the engines manufactured at the works of Messrs. Musgrave & Sons, and Messrs. J. and E. Wood, but eventually deferred for further consideration the tenders for the supply of engines until August 4th. The tenders for the erection of the buildings required for the generating station was also deferred for future consideration.

Electricity on Shipboard.—The Metropolitan Asylums Board have accepted, subject to the sanction of the Local Government Board, the estimate of the Electrical Power Storage Company, Limited, for a battery and instruments for lighting the store-rooms on the ships *Atlas* and *Endymion* by electricity at £124 16s. 11d.

Cardiff.—At a meeting of the Cardiff Lighting Committee, held last week, tenders were received for pipes to be utilised for the protection of electric cables underground, the tender of Messrs. W. E. Hampton & Co., who undertook to supply 150 tons of socket and spigot cast-iron pipes at £4 11s. 3d. per ton, and socket and spigot branches, bands, and joints, at £7 14s. per ton, being accepted. The tender of Messrs. Siemens, Bros. & Co., Limited, for the supply of 48 ampère band arc lamps, at a cost of £276, was also accepted.

Hampstead.—The Hampstead Vestry has accepted the tender of Messrs. R. A. Yerbury & Sons, of Kilburn, for the erection of a chimney shaft and buildings for the proposed Hampstead central electric supply station, with the foundations for the machinery, &c., in conformity with specifications and plans prepared by Mr. Preece, for £7,350, and the tender of Messrs. Siemens Bros. and Co., for the supply of electric lighting plant, mains, &c., for the area at first to be lighted, for £19,794.

Nottingham.—The tender of Mr. F. Messon, of Nottingham, for the erection of the new electric lighting station in Lower Talbot Street, at £10,209, has been accepted. There were 14 tenders sent in.

BUSINESS NOTICES, &c.

J. A. Berly's Universal Electrical Directory for 1893 (12th year), 784 pp. This standard work contains a larger amount of trade information than any other similar publication, and should be in the hands of every engineer or electrician. Free within the Postal Union for 4s.

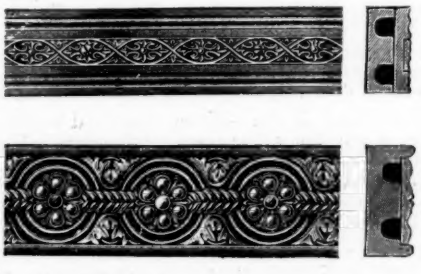
The "Rabbidge" Portable Telephone.—The production of a telephone instrument both cheap and reliable, to be utilised for short distances instead of the ordinary speaking tubes, in such buildings as hotels, warehouses, factories or ships, has been aimed at by many men within the past few years. So far, instruments of this kind have proved almost impracticable, as well as being far too costly to maintain on account of their delicate construction and adjustment, which naturally entailed a great deal of skilled attention. Mr. Parnell Rabbidge, who is at present in England, has spent several years in endeavouring to surmount these difficulties, and claims to have succeeded in completing a cheap, compact, portable, and reliable telephone, which has stood a twelve months' test without requiring either adjustment or attention. The instrument consists of a transmitter and a receiver, which are rigidly connected together in such a manner that they may be used simultaneously. But in addition to this, the receiver is also made to act as the alarm or call in place of an electric bell, and in the handle there is enclosed an automatic gravity switch, by which the alarm circuit is closed when required. By this improved construction all the parts of a telephone instrument are arranged and combined with one handle in a compact and simple form, and the necessity for a complicated instrument to be fixed to the wall, or any other suitable position, is entirely done away with. The advantages gained by having the instrument so combined are, we understand, very numerous. It is said to be much simpler and cheaper to construct, also more reliable than other similar instruments. By leading a flexible wire from it to a small plug made to fit the plug switch, it can be made portable and interchangeable, which is very useful for hotels or on board ship. The fittings cannot get out of order, such as the wires and plug switches, and can be fixed permanently to any required places throughout large buildings or ships, at a little cost by any ordinary mechanic, either when the building is being erected or otherwise. The instrument could then be attached at any time required, by simply inserting the plug that is connected to the telephone by a flexible cord into the required hole of the plug switch, and hang the telephone on a small hook with its receiver downwards, it is then ready for use. When the instrument calls, it is only required to lift the instrument to the ear, the gravity switch will then cut the call out and bring the transmitter into circuit, so that speaking communication can be carried on. In private houses the plug switch can be fixed so that anyone can get their own instrument if they choose, and use the ordinary bell circuit to speak through. The instruments will all be made to one size and pattern so as to make them interchangeable. The microphone is made quite reliable, and will not vary with temperature. This invention is protected in England by four patents, and is also well protected all over the world.

The Crystal Palace District Electric Supply Company, Limited.—On Friday evening, July 28th, Mr. George Offor, the general manager and secretary of this company, delivered a lecture on "Electricity as applied to Domestic Purposes," before a large audience in the music room of Westwood House, Upper Sydenham. The lecture was in three divisions, the first dealing with the importance of the undertaking carried out by the company in the locality, the second treating of the uses of electricity for domestic purposes, and the third with the progress and commercial success of electric supply companies. Mr. Offor pointed out that his company possessed a most promising field for their great enterprise, the area having been selected by himself as an old resident, well acquainted with the requirements of an electric supply company, with a special view to a profitable district. Taking the Crystal Palace as a centre, all the important residential neighbourhood surrounding it had been included in the area of supply, which extended about 2 miles from north to south, and 1½ miles from east to west. Between 7 and 8 miles of trenches had been constructed in the public roads and footpaths, in which more than 50 miles of cables had been laid, consisting of high tension continuous current mains between the generating

station and seven transformer sub-stations, low tension distributing mains from these points on to a complete network, and pilot wires for regulating the pressure which is delivered at 100 volts. At each sub-station there is a motor dynamo and battery of the Electrical Power Storage Company's accumulators of the "K" type. The second division of the lecture was illustrated by a most successful exhibition of cooking, ironing, ventilating, cigar-lighting, &c., the apparatus and a very beautiful selection of electric light fittings being lent for the occasion by Messrs. Rashleigh Phipps & Co., of 102, Oxford Street. A dish of cutlets, an omelette, excellent coffee with hot milk, were prepared at the same time, in less than 10 minutes. In the third part of the lecture, Mr. Offor showed the rapid progress of the electric supply industry, and referred to the dividends paid by a large number of metropolitan and provincial companies, as indications of the future success of his own company. Mr. Offor mentioned that the first house was connected with the company's mains in February last, and there were already about 3,000 lamps actually running or being wired for, and numerous enquiries were being received.

Fowler-Waring's New Catalogue.—The new catalogue—if we may call it such—just published by the Fowler-Waring Cables Company is an excellent piece of work. The appearance and get-up of the book are far superior to the generality of work in catalogues. It consists of about 80 pages of good paper, has been very cleanly and neatly printed, and is bound in thin cloth covers of a kind of chocolate colour; on the front cover is set forth in gold lettering the object of the catalogue as follows:—"Fowler-Waring cables for electric lighting and transmission of power, telegraphy and telephony." On the front pages are process illustrations of the works, and some process sketches taken in the factory by Dudley Hardy, showing the operators engaged in their various occupations, *i.e.*, stranding, spooling and brading. Then follow very minute details regarding the cables; testimonials from recognised authorities in cable work lead the way, followed by some very useful reference tables giving particulars of conductors; particulars and prices of low-tension electric light lead-covered wires and cables; high-tension cables. Special attention is directed to some new features, *i.e.*, the illustrations of junction boxes and fittings for lead-covered cables, which are now being so extensively adopted, and which have in a great measure overcome the difficulties first experienced in the jointing of these mains, and in the distribution from them. In the section of the catalogue which deals with concentric wiring we notice a fully illustrated description of junctions, switch boxes, &c., specially adapted to lead-covered cables. These fittings have already been extensively adopted both in this country and abroad, and have enabled the company to apply lead-covered cables throughout a large number of installations. Description and illustrations of "dry core" cables are also included in the volume. The three-wire system has several pages of coloured illustrations set apart for it. Concentric wiring calls forth some extensive remarks, and a number of illustrations likewise coloured; switches and such like, and many accessories and apparatus used in connection with cable work, are dealt with in an interesting manner. A very noticeable feature in the catalogue is the very effective colouring of the greater part of the illustrations, which is very nicely executed. On the whole, the publication is interesting as well as attractive.

Improvement in Wire Casings.—The Wood Carving Company, Limited, of Birmingham, have patented a mechanical system of wood carving, which is, we believe, entirely their own, and



by it they accomplish the decoration of wood in numerous designs. Electric light casings with their carved surfaces, we understand, can be supplied at a cost very little in excess of the ordinary plain patterns.

A New Lamp Filament.—We are informed that Mr. Arther Shippey has succeeded in producing a new compound material for incandescent lamp filaments, which material can be pressed into sheets and cut into all conceivable shapes according to the actual requirements of the incandescent lamp industry. The material is called "Fiberite." By this new process it is estimated that 1s. per year outlay will cover the consumer's cost per lamp for incandescent lighting, but this must be taken as the outcome of Mr. Shippey's vivid imagination, and not, we should say, quite seriously. It is said that for lighting by batteries the "Fiberite" compound can be blended with metallic substances, and a good low resistance incandescent lamp produced. "If this new lamp turns out as we expect, which we have every reason to believe it will," remark Messrs. Shippey Brothers, "we have no hesitation in saying that this company, as soon as financial arrangements are made to manufacture these lamps on a large scale will be able to revolutionise this electric industry as far as incandescent lighting is concerned." The wonder to us is that Messrs. Shippey Brothers have not already revolutionised the "electric industry" to such an extent that nothing else is left for them to turn over.

Glasgow Gas and Electric Lighting Accounts.—The first balance-sheet of the Glasgow Corporation electric light undertaking shows the gross revenue to be £7,784 5s. 4d., and the expenditure £5,416 4s. 11d., to which is added £1,328 for depreciation and written-off capital, leaving a balance of £1,039. Interest on loans, amounting to £2,812, and a contribution of £800 to the sinking fund, had also to be met, and, deducting from these the above balance, there remains on the year's operations a deficiency of £1,773. The committee recommend that the price of the electric energy be continued at the same rate—7d. per Board of Trade unit. When the undertaking was acquired the number of consumers was 37, while at the end of May there were 108. The accounts of the Gas Committee show a gross revenue for the year of £594,048, and there is a surplus of £28,037, of which £26,139 covers the debit balance of last year, and £1,773 goes to make up the loss on the electric lighting account. The quantity of gas sold or accounted for was 3,819,039,000 cubic feet, an increase on the preceding year of over 4 per cent. The sinking fund stands at £266,446.

Consolidated Telephone Construction and Maintenance Company, Limited.—Mr. Buckley, Q.C., applied on Saturday to Mr. Justice Stirling for power to reduce the capital of this company. He stated that in consequence of the taking over of the Telephone Company of Austria, in which this company held shares, by the Austrian Government, a sum of about £50,000 had been set free, and this sum it was proposed to utilise by paying off the preference shares of £1 each, which would absorb £22,400. Then, on account of the running out of several of the patents under which the company worked, there had been a depreciation in the assets of the company, which the directors estimated to be not less than £24,000, and they desired to write off 2s. per share on the ordinary shares on account of loss. The result would be that funds would be available for the payment of dividend. His lordship made the necessary order, remarking that it was merely a return of capital in excess of the requirements of the company.

Opening of Huddersfield Electric Lighting Station.—On Saturday last was officially opened, at Huddersfield, the Corporation Electric Supply Station in St. Andrew's Road. The station has been erected in a suitable manner to meet a demand of 40,000 8-C.P. lamps, if eventually necessary. The machinery already put down will supply 9,000 lamps, but the demand is said to have been so great that it has been found necessary to double that number. The total cost of the work was £29,693. The contract with the Brush Electrical Engineering Company amounted to £20,640, which was for the plant and mains alone. The high tension system has been adopted. The charge to consumers is at present to be 6d. per Board of Trade unit.

Allgemeine Elektricitäts-Gesellschaft.—This company have brought out, in pamphlet form, an account of their exhibits at the Chicago Exhibition. A number of very nice illustrations are included. In addition to the description of Chicago exhibits, some information is given regarding the general business of the company, this subject being illustrated by several full page process blocks. One of these shows the plant used for the transmission of power from Lauffen to Frankfort, while others show an electric crane erected at Hamburg by the company, Halle electric tramway, an electric launch, central station of the Berliner Elektricitäts-Werke. On the whole the pamphlet is well and neatly got up.

The Central Markets Electric Lighting.—In further reference to the matter between Messrs. Sax & Co. and the Corporation, at the last meeting of the authorities the committee's report was presented, recommending that a building lease for 80 years of a piece of land in Charterhouse Street, at a rental of £500 per annum, subject to certain modifications, should be granted to Messrs. Julius Sax & Co. These modifications made it conditional that no more than £6,000 should be paid for the building in case the Corporation required the land at any future time, and further that the notice should be six months, and no compensation should be claimed. The Court approved of the committee's recommendation.

Business Alteration.—We are informed that after the 15th inst. Mr. W. C. Martin will cease to be connected with Messrs. Paterson & Cooper as their agent for Scotland. Mr. E. G. Tidd has been appointed to take his place. Mr. Tidd has, for many years, been connected with the firm, and has personally superintended many of the most important electric light installations carried out by them in England. He is an Associate Member of the Institute of Civil Engineers and an Associate of the Institute of Electrical Engineers. The Glasgow and Dundee addresses will be the same as before, namely 137, West Regent Street, Glasgow, and Maritime Buildings, Dundee.

Glasgow Electric Lighting Extension.—The Town Council have under consideration at present a scheme for the extension of the electric lighting system. This scheme contemplates the removal of the dynamos from the establishment in Waterloo Street to the premises in John Street, formerly occupied by Messrs. Mavor & Coulson, and now the property of the Corporation, with a view to utilising them for supplying electricity for street lighting. This would leave room at Waterloo Street for the supply of incandescent lamps for house lighting.

Cathcart, Peto, and Radford.—This firm, we understand, have been very busy during the past few months, especially in their installation department. They have just lately secured an order from Messrs. C. Brown & Co., to fit up about 250 lights in their new flour mills at Shadwell. They are also completing an installation at the new dry plate factory of Messrs. Caddett & Neale, Ashtead, where electric power is being used for both light and motive power, all the machines being driven by motors.

Wolverhampton Electric Lighting.—A local Government Board inquiry was held last week into the application made by the Town Council for sanction to borrow certain sums of money for public improvements; £1,927 for electric lighting purposes was one of the items under consideration. It transpired that 4,066 yards of land had been purchased in Commercial Road at a cost of £1,927, including legal expenses. It is not improbable that a destructor will also be erected on this land. The Town Clerk was unable to state the system of electric lighting to be adopted. An alderman stated that plans were being made by the recently appointed electrical engineer with the view of obtaining tenders for the work. It is proposed to almost immediately commence building the stack, the present months being more suitable than those of the winter for such work.

Lighting an Aerial Castle.—An aerial castle, to be formed of two balloons connected together by means of three cylindrical compartments, and made captive by four stout cables, is to form the attraction of the proposed international exhibition in Antwerp next year. The castle, which is to accommodate 150 persons, is to be lighted at night by thousands of electric lamps, the current to be supplied from the generating plant illuminating the exhibition and grounds. Passengers will be conveyed to the castle by small balloons.

Slater Lewis's Bankruptcy: A Correction.—In our account of Mr. J. Slater Lewis's bankruptcy, an error unfortunately occurred in line 21, page 102, where we say that Mr. Goolden considered Mr. Slater Lewis "incapable of any *un*questionable conduct." As would be evident from the context, however, this should read "incapable of any questionable conduct." We regret the error, but our readers would understand what was intended from Mr. Goolden's statement, that he had formed a very high opinion of the bankrupt's character.

Gas v. Electricity.—The Halifax Flour Society have effected a great saving through the adoption of the electric light. In 1890, when they had no electric lighting, they paid £174 0s. 1d. for gas; in 1892 the total cost of gas and electric lighting was £122 5s. 8d., a saving of £52. In addition, through adopting electric lighting, they were able to save from £60 to £70 in insurance premiums. The saving was all the more significant, because last year they ground 127,156 quarters of flour compared with 100,048 quarters in 1890.

The Electric Light in Newspaper Offices.—The installation of the electric light in the offices of the *Yorkshire Post*, at Leeds, is now complete, and consists of upwards of 400 incandescent lamps. The current is taken from the mains of the Yorkshire House-to-House Electricity Company, and the scheme of the installation with the specification was prepared and superintended by Mr. E. W. Lanchester, of Birmingham. The contract was undertaken by Messrs. S. Dixon and Sons, who are devoting special attention to private installation work.

Leicester Electric Lighting.—The ratepayers have not yet altogether quieted down at Leicester. The Chairman of the Ratepayer's Association communicated to the mayor a request for a special town's meeting to consider the Corporation's proposal regarding the electric light. The mayor has replied refusing to call such meeting as the ratepayers have already been in communication with the Local Government Board, who intend holding shortly a public enquiry as to the electric lighting loan for which the Council have applied for sanction.

Removal.—Mr. G. Braulik, of 72, Mark Lane, London, E.C., owing to increase of business, will remove on 8th inst. to more commodious premises at 217 and 218, Upper Thames Street, E.C., where he intends to keep a larger stock of all kinds of electrical appliances. He intends keeping a stock of Korting & Mathiesen's arc lamps, incandescent lamps (after expiry of patents), light carbons, electric light fittings, glass accumulator boxes, and storage batteries.

Sad Accident to a Watchman.—On Saturday afternoon William Bowles, who is employed at the Corporation Electric Lighting Works, Nottingham, was assisting several men to unload an engine, when a quantity of flagstones, weighing about 10 cwt., fell on him. It was some time before the unfortunate man could be extricated, and he was removed to the infirmary, where it was found that he was suffering from severe internal injuries.

The Watt Arc Lamps.—The United Electric Light Company draw our attention to their latest patterns of the Watt arc lamps, which require 3 and 5 ampères at 50 volts and give 250 and 500 C.P. respectively. Where large arc lamps are unnecessary and incandescents inadequate, the Watt lamp should be, as regards size, especially useful. The company guarantee for the lamps high efficiency, and claim fairly long hours of burning.

Downpatrick Commissioners and Electric Lighting.—The lighting of the extended boundary was considered the other day by the Downpatrick Commissioners, and it was resolved, that unless a satisfactory arrangement be made with the gas company before Monday, some other means of lighting be adopted. The chairman said that an electric engineer in Belfast was prepared to give an estimate for lighting the town by electricity.

Code Telegrams for Pernambuco.—The Eastern Telegraph Company, Limited, notifies that code messages may be accepted for Pernambuco at sender's risk, subject to receivers producing translations for inspection there. The prohibition of code by the Brazilian Government to all other parts of Brazil continues in force; but non-political plain-language messages are delivered without restriction.

Rugby Electric Lighting.—At the meeting of the Local Board, on Saturday, an application was received from the Rugby School Electric Lighting Company, asking the board to undertake the task of laying the cast-iron pipes for the cables where they crossed the public road, in order to avoid the difficulty of having to make good and maintain the surface of the road afterwards. The board agreed to undertake the work, subject to their being relieved from all subsequent responsibility.

The Electric Light at the Southampton Free Library.—The new public library which was opened on Saturday by the Dean of Winchester is lighted by electricity, which is generated on the premises. The work was entrusted to Messrs. Demmson and Parmiter, electrical engineers, of Manchester. The dynamo is capable of running 110 lamps of 16 C.P.

"Provincial Press in London."—This book, to which we referred a few weeks ago, is now published and on sale at 100, Fleet Street. Only the provincial papers that are represented in London have a place in the book. We, however, think the directory may be useful to advertisers, and to those desirous of communicating with the more important provincial papers.

Traction in Plauen.—The Saxon Government having now moderated the conditions under which the proposed electric tramway is to be built, the General Electricity Company of Berlin, who have obtained a concession for the line for a term of 50 years, will shortly commence the construction of the line.

Hull Electric Lighting.—A Pulsometer pump has been fixed in order to enable Messrs. Callender & Co. to proceed with the work of laying the mains under the lock of the Prince's Dock.

The Local Government Board have given their sanction to the loan of £10,000 for electric lighting purposes.

Electric Construction Corporation.—In the Chancery Division on Wednesday, Mr. Justice Vaughan Williams made an order for the winding up of the Electric Construction Corporation, Limited, under the supervision of the Court. The order was made on the petition of Sir Daniel Cooper.

Hampstead and Charing Cross Electric Railway.—The Unopposed Bill Committee of the House of Lords on Monday passed the Hampstead, St. Pancras and Charing Cross Electric Railway Bill. This scheme has already been sanctioned by the House of Commons.

Edinburgh Shop Lighting.—Bailie M'Donald has had his establishment at 40, South Bridge, lighted by electricity. The installation was fitted up by Mr. D. Hunter, of Lanark. There are 56 lamps having a total illuminating power of 3,320 candles.

Southport and the Electric Light.—At a special meeting of the Southport Town Council last Wednesday, the gas committee recommended a scheme estimated to cost £13,000, the generating plant to be erected at the gasworks, Blowick.

Balloon Lighting.—The "Phœnix," a German balloon used for scientific investigations undertaken at night, is lighted by means of four incandescent electric lamps supplied from a small battery on the car.

Mansion Electric Lighting.—Newton-Donn mansion, stables, &c, have been fitted up for electric lighting, the current being turned on a few days ago for the first time. There are about 300 lights.

Peterborough Electric Lighting.—The Town Council have refused their consent to the proposed application of the Midland House-to-House Electricity Company for a provisional order.

W. T. Goolden & Co.—We are informed that the works and offices of this firm will be closed for the annual holidays, from August 28th to September 2nd inclusive.

Personal.—Major-General C. E. Webber, C.B., has been appointed by the Royal Commission one of the delegates to the Electrical Congress at Chicago.

Telegraphic Interruptions.—Owing to the recent destructive floods in Kashmir, telegraphic communication with that place is at present defective.

Messrs. Schuckert & Co., of Nürnberg, whose business was recently converted into a limited company, have acquired the Haardt electricity works.

Electric Lighting of Business Premises.—The Haswell Co-operative Society has decided to instal electric lighting into their premises.

CITY NOTES.

Chili Telephone Company, Limited.

THE ordinary general meeting of the Chili Telephone Company, Limited, was held on Wednesday at Winchester House, Col. R. Raynsford Jackson (chairman), presiding.

In moving the adoption of the report, the CHAIRMAN said that the net profits in London for the past year amounted to only £5,395, although the income in dollars from subscribers showed an increase of

869,831. The fact was that the fall in exchange was directly responsible for a diminution in their revenue of £7,642. As the tariff rates were paid in the paper dollar, which was now so greatly depreciated, the board felt that they ought to increase those rates. Already that course had been pursued in some important centres, and they were about to do the same in all of them. Another thing on which they relied was the decision arrived at by the Chilian Government to gradually withdraw the paper money and establish a sound currency. The profit earned during the past year was used for capital purposes, but they had now practically closed that account, at least for the present, as they were only spending the money necessary to couple up new subscribers. He hoped, therefore, that during the current year they might be able to set aside, out of revenue, a sufficient amount with which to pay a dividend.

Mr. T. GREENWOOD seconded the motion, and the report was adopted.

Manchester Edison-Swan Company, Limited.

The eleventh ordinary general meeting of this company was held on July 28th, Mr. V. K. Armitage, chairman of the company, presiding.

The CHAIRMAN, in moving the adoption of the report, referred to the depressed state of electrical business and business in general during the past year, and said the Manchester Edison-Swan Company had suffered a good deal through the delay of the Manchester Corporation in carrying out their installation, as people did not care to go forward with installations on their own account till they saw what the corporation were going to do in the matter. The corporation seemed now to be within measurable distance of the completion of their works. The net profits of the company had been about £800 less than in the preceding year. Although the result was to that extent unfavourable, he was not without hope as to the future of the company. There could be no doubt that there would be a very great spread of electric lighting in the immediate future, and they hoped and believed they would get their share of the work that had to be done. Nearly all the business they had done had been remunerative work, and with increased business they would have an increase in the amount of their profits.

The motion was seconded by Mr. W. P. JAMES FAWCUS, and after some criticisms on the accounts had been passed by Mr. C. HOPKINSON, it was put to the meeting and adopted, with only one dissentient.

It was agreed that the profits should be disposed of in the manner suggested in the report, except that out of the balance to be carried forward, £150 was voted as remuneration to the directors. Thanks to the chairman and other directors concluded the proceedings. Before and after the meeting the shareholders had an opportunity of inspecting the new showrooms of the company, in which the meeting was held. The rooms are situated in Victoria Street, at the foot of the approach to the Exchange station.

Electrical Power Storage Company, Limited.

The report of the directors reads as follows:—

"The directors beg to present to the shareholders the report and accounts to May 31st, 1893. The profit, after payment of general expenses, management, &c., is £5,245 2s. 2d., from which the directors have, in deference to the wishes of the auditors, deducted a sum of £1,500, writing that amount off the patent account, leaving, with a balance of £626 7s. 7d. from last year, an amount of £4,371 9s. 9d. available for distribution, out of which the directors recommend the payment of a dividend of 5 per cent., leaving £158 19s. 5d. to be carried forward. Provision has also been made for maintenance of buildings, plant, tools, &c., by writing off the sum of £2,083 18s. 9d. The directors are pleased to be able to report the continued success of the company's operations; a considerable reduction in the selling price of its manufactures has been made, for the purpose of bringing storage batteries into more general use. Particular attention has been devoted to securing such inventions as would tend to cheapen production while combining maximum efficiency and durability; and with this object several new patents have been acquired, and sole licenses for others have been obtained. Constant attention has been also given to the development of electric traction, for which the directors expect a considerable demand will shortly arise. The company and its licensees have been successful in patent litigation abroad. The retiring director is Sir Daniel Cooper, Bart., G.C.M.G., who, being eligible, offers himself for re-election. The auditors, Messrs. Broads, Paterson & Co., retire as usual.

PROFIT AND LOSS ACCOUNT for the year ended May 31st, 1893.

DR.	£	s.	d.
Rent, taxes, licenses, &c., £9,845 7s. 8d.; less rebate on payment of dividend at the rate of 5 per cent. per annum on ordinary shares, £4,000 ...	5,845	7	8
General expenses, management, directors' fees, &c. ...	6,266	18	6
Advertising, insurances, and travelling expenses, &c.	2,555	19	9
Commissions, interest, &c.	1,467	15	3
Patent fees and charges and law expenses	1,943	6	5
Patents, &c.:—Depreciation written off	1,500	0	0
Maintenance of buildings, plant, and tools	1,860	6	6
Depreciation written off plant, tools, &c.	108	13	2
Auditors' fees	120	0	0
Balance, being net profit carried to balance-sheet ...	3,745	2	2
	£25,453	9	5

CR.	£	s.	d.
Balance from trading account	25,215	9	3
Rents receivable, &c.	238	0	2
	£25,453	9	5

BALANCE SHEET, May 31st, 1893.

LIABILITIES.

DR.	£	s.	d.
Capital authorised—20,100 shares of £5 each, of which 100 are founders' shares	100,500	0	0
Issued 18,723 shares of £5 each, of which 66 are founders' shares	93,615	0	0
Paid up 15,120 shares fully paid, £75,600; 3,537 shares £3 paid, £10,611 = £86,211; less calls in arrear and on forfeited shares, £1,369 1s. 3d. = £84,841 18s. 9d.; less amount paid on forfeited shares, £400 = £84,441 18s. 9d.; add 66 founders' shares fully paid, £330	84,771	18	9
Sums paid on forfeited shares	400	0	0
Sundry creditors	7,024	14	7
Bills payable	15,192	16	11
Profit and loss account—Balance of account at May 31st, 1892, after paying dividend at 6 per cent., £746 7s. 7d.; less auditors fees to May 31st, 1893, £120; add profit for current year, £3,745 2s. 2d. ...	4,371	9	9
	£111,761	0	0

ASSETS.

CR.	£	s.	.
Patents, &c., at Cost—Amount at May 31st, 1892, £75,160; purchased during the current year in exchange for fully-paid shares of the company, £600; less amount written off to profit and loss, £1,500	74,260	0	0
New plant, tools, furniture, fixtures and fittings, £1,086 11s. 2d.; less 10 per cent. depreciation, £108 13s. 2d.	977	18	0
Stock in Hand—General stock at cost or under, £12,527 7s. 5d.; stationery at cost, £229 18s. 2d.; less 50 per cent. depreciation, £114 19s 1d. ...	12,642	6	6
Book debts, less reserve for discounts and doubtful debts	16,697	8	1
Bills receivable	1,251	8	7
Investment account	600	0	0
Cash at bankers, £5,292 8s. 1d.; in hand, £39 10s. 9d.	5,331	18	10
	£111,761	0	0

We have examined the above accounts with the books and vouchers of the company, and find the same to be correctly stated, subject only to the adequacy of the provision for depreciation.

BROADS, PATERSON & Co., *Auditors*,
1, Walbrook, E.C.

July 19th, 1893.

The fourth ordinary general meeting of the company was held at the offices of the company, 4, Great Winchester Street, E.C., on Thursday, July 27th. We received no notice of the meeting, and therefore were unable to publish our own account. The following report is furnished by the secretary:—

Mr. J. IRVING COURTENAY, who presided, said:—In making some observations upon the accounts, I desire to point out that the difference in the balance carried forward from the trading account this year and last year is mainly owing to proper deductions having been made in balancing the trading account, the discounts and other charges having been deducted before bringing forward the balance. The gross amount of orders is larger than last year, but owing to the reduction in price, and increased discounts to the trade, the net cash received is rather less. But you will also notice that in consequence of economies having been introduced into the management and into the manufacture, the net profits are practically the same, because from the amount of the profits we have written off this year, £1,500 towards depreciation of patents. The company is selling more of its manufactures than it did, and thus it is increasing its goodwill and obtaining a larger business with the public, because the objections taken in past years to the high price of accumulators have been, to a considerable extent, removed by the reductions in question. Now you are all aware of the depressed condition of trade, and that the electrical industry, like all other businesses, is suffering from the depressed times; but I am glad to say that the E.P.S. Company has done well, in spite of this almost unprecedented depression. We do business with all the leading firms, and the result is that whatever business is going we get a share of. We have competition to contend against, and no doubt shall always have; but I think by the improvements that have actually been made, and those we have in contemplation, and by the economics these will effect in the manufacture of the batteries, we shall be able to hold our own. We are, as you are aware, also acquiring patents for details in manufacture, and so in reality, though the basic patents are growing older, we are strengthening the position by these newer patents. One of the most vital questions for the E.P.S. Company is

traction. You know that this company associates itself almost entirely with what is called self-contained traction, and has endeavoured to develop it, though up to the present not with the results we aim at; but we do not for one moment despair of ultimate success. A portion of the expenditure in legal charges was incurred in what at one time looked a hopeful business, in endeavouring to obtain an Act of Parliament in an important provincial town for an electrical tramway. We failed because we could not get the necessary agreements confirmed in time for Parliament, and so the bill was dropped. But we are persevering (not in that particular locality) with self-contained traction, and you have heard of a small company that has been formed—I refer to the Pioneer Electric Carriage Company—to develop a form of traction with novel features, among which is the pneumatic wheel. Some few of our friends have put their money in to test it, and, if successful, it will be a great benefit to the E.P.S. Company, and bring a wide demand for its batteries—such is the interest the E.P.S. has in the welfare of that concern. I do not think I need trouble you with any further remarks, and conclude by saying, so far as is possible to see ahead in these days, I entertain no doubt that the E.P.S. Company will continue to prosper. I now move: "That the directors' report and statement of accounts to May 31st, 1893, be and are hereby approved and adopted, and that a dividend of 5 per cent. on the paid-up capital be declared, payable on August 24th, 1893."

This was seconded by Sir DANIEL COOPER.

After some remarks by a SHAREHOLDER, the resolution was carried unanimously, and the retiring director, Sir Daniel Cooper, Bart., G.C.M.G., was re-elected.

City and South London Railway Company.

THE eighteenth ordinary general meeting of the proprietors of the City and South London Railway was held at Winchester House on Tuesday morning, under the presidency of the chairman, Mr. Charles Grey Mott.

The SECRETARY (Mr. W. F. Knight) having read the notice convening the meeting, it was resolved to take the report (which appeared in our last issue) as read.

The CHAIRMAN said it became his duty to move the adoption of the report and accounts. They would be pleased to see a steady increase in the receipts during the past half-year in spite of the long continued fine weather, which was, as a rule, detrimental to the traffic of the line. Then they had the satisfaction of knowing that there had been no increase in the expenditure, but on the contrary there had been a small decrease, so they had increased receipts with decreased expenditure, which was a most satisfactory condition in all things. Then they had again to report that the line had been worked with the greatest regularity, and without any stoppage in any way. The line was, he thought, growing in popularity with the public. They found that it was almost unexampled in regularity of its service and its punctuality; that it has a pure atmosphere free from noxious vapours and the temperature pleasant both in summer and winter, and altogether the line was one such as was wanted very much in the metropolis, and it was a great improvement upon all existing railway lines. He would just shortly call their attention to a few of the items in the accounts. In the first place, as regarded capital expenditure, they had received £17,050 during the half-year, which they had used in paying off liabilities amounting to £10,209, and on the Stockwell sidings and various other matters, amounting to £6,181, which accounted for nearly the whole of the £17,000. They had paid off during the half-year £38,000 terminable debentures, and replaced them with 4 per cent. debenture stock issued at a premium. So they had effected a small saving in that respect. The amount of debentures that fell due during the half-year was exceedingly small, but in the future it would be larger, and they would get a larger benefit and more saving each half-year until the whole was paid off or converted. They now came to the most interesting part, which was the revenue account. The revenue receipts had increased £1,491; season tickets showed an increase of £36; parcels, £9; transfer fees, £4; rents, £79; and other sundry receipts increased £21; so that there was an increase in every department of receipts, making a total increase of £1,639. On the other hand, the expenses of maintenance increased £13 on taxes; locomotive expenses £159 increase; carriage repairs had increased by £57; traffic expenses decreased £124, and general charges increased £160. He might state that the increase in the general charges was greatly due to what he thought they would greatly approve of, and that was insurance against accidents. They decided that being a small line, although liability for accident was exceedingly small, not to run any risk which would interfere with dividends, they therefore had insured against accident. They paid £200 a year, and got insurance to a considerable amount. He trusted the accident company might reap the benefit, and that they might have no claim upon them; but at the same time they would agree with what the directors had done. Then that half-year they had to pay £24 for passenger duty. Many would have noticed the questions asked in the House of Commons on that subject. The fact was, the matter had been under discussion for years. The Inland Revenue taxed them, but as they did not have tickets they had no means of knowing how far passengers travelled, and therefore held that they had a right to travel the whole of the distance, and they said they were not liable for any duty. The Inland Revenue contended that a certain number of passengers did not travel sufficiently to make the rate 1d. per mile, and as it was impossible for either side to ascertain the number who travelled short distances, a compromise had been effected, and they had endeavoured to arrive at a fair amount, and that half-year they had to pay £24, which was also for one or two half-years before. Their law charges had decreased £32, and rates and taxes increased £44; and compensations decreased £117. Altogether there was a decrease in the expenditure of £134, which, added to the increased revenue made an increase of £1,773. There was one item which he should like to say a word or two on, and that was the rates and taxes. That was going up steadily, and they could look forward to still greater increase in the future. It affected all railways in the country. Unfortunately there was at the present day a spirit abroad which was a retrograde one. They were going back to the doctrine of "Cæsarism," when everything is to be done for the people, and nothing by the people. It had been found in the past, and it would be found in the future, that that doctrine led to a large increase in public expenditure, and, at the same time, took away that self-help and independence which was the great help of the nation. As long as that doctrine was abroad, they would see an increase of imperial and local taxation, and until they found out their mistake, they might look forward to a steady increase in that direction. They would be interested to compare the average working expenses of the past with the present. In their first half-year they were 79 per cent. of the receipts; in the second 76 per cent.; in the third 70 per cent.; the fourth 67·9 per cent, and in the fifth, and last, 64·6 per cent. They would see from that there had been a steady and regular decrease in the expenses, and he hoped that would go on in the future, as in the past, until they got them down to a much lower rate than at present. As he had pointed out before, those expenses included the item of lifts, which was not an expense connected with other railways. If they deducted the cost of the working of lifts, their expenses would only be about 56 per cent., which was about the same as that of the larger railway companies, and it might interest them to notice the changes that had taken place in the receipts per train mile on the line. They began with 2s. 1d. per train mile; in the second half-year it was 2s. 1½d.; third, 2s. 2½d., and then they put on a large increase, and the rate fell to 2s. That half-year they had only put on a small addition, for the receipts had risen again to 2s. 1½d. The expenses, on the other hand, per mile, had been in the first half-year 1s. 9½d.; in the second 1s. 7¾d.; in the third 1s. 7½d.; in the fourth 1s. 5¾d., and the last half-year 1s. 4½d. Their locomotive expenses were, in the first half-year, 9 per cent; in the second 7·9 per cent.; in the third 7·7 per cent.; in the fourth 7·1 per cent., and in the last 6·48 per cent. The receipts per passenger had been, in the first half-year, 1·90d.; second, 1·70d.; third, 1·73d.; fourth, 1·60d., and the last half-year 1·66d. They had been trying to get a larger number of short distance passengers at reduced fares, which, whilst it increased their receipts, reduced the average per passenger. The new siding at Stockwell was practically complete, and would shortly be brought into use. They were anxious to have it in use before the winter traffic commenced, as it would, he thought, enable them to give more service during the winter, and they had also been enabled to put in an additional signalling station between Stockwell and the Oval. Their Bill for the extension to Islington had been passed by the House of Lords, and had gone down to the Commons to be slightly altered before receiving the Royal assent. In order to try and improve the King William Street Station, they had acquired some adjoining property at a very low price, and they would do their best to improve the station at the smallest possible cost. He would not detain them longer, but move that the report and balance-sheet be received.

Mr. C. S. GRENFELL seconded the proposition, which was carried.

The CHAIRMAN next moved that a dividend of 5 per cent. be paid on the preference stock.

Mr. HANBURY seconded, and the resolution was carried.

The CHAIRMAN then moved the payment of a dividend of ¾ per cent. on the Consolidated general stock, which was seconded by Mr. HEMARD, and carried.

Mr. DRAKE moved a vote of thanks to the chairman and the board, and said that the company was the pioneer one in London, and it was with pleasure he noticed the progress in the dividend.

Mr. SOMERS (Yorkshire) seconded the motion, which was carried.

The CHAIRMAN expressed the pleasure it gave himself and the Board to find their efforts appreciated, and he trusted they would make the undertaking a great success. He looked forward with a confident hope to the future, for although they moved slowly, they were absolutely sure. If they went on as in the past, he felt sure the time would arrive when they would have no cause to be disappointed at their dividends.

Edison & Swan United Electric Light Company.

THE annual meeting of the shareholders of the Edison & Swan United Electric Light Company, Limited, was held last Friday at the Cannon Street Hotel, E.C., under the presidency of Mr. James Staats Forbes (the chairman of the company).

The SECRETARY (Mr. H. Charles Gover) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I think the essential part of the report is in a nutshell, and it is embraced in this—that the gross receipts of the year are the largest the company has ever obtained, the expenses are exactly in the same description, for reasons which I will presently explain, and the net profit for the year has been increased by £11,832. The position of the company is, as you know, approaching a moment when there will be a considerable change—the period of protection will expire in November, and we should have been very much failing in our duty to you if we had not anticipated that period for some years. We have been working on a well-considered design for a number of years, that design being that when we emerge from protection, we shall be prepared for competition. This is the tenth complete year of our existence, and it is worth while calling to mind that in the first five years we paid no dividend at all, and we began the sixth year with an enormous incubus in the shape of the cumulative claim of the "A" shareholders—£121,000 in round figures. During the five years succeeding, electric lighting extended

somewhat rapidly in comparison with the earlier years, and we have been able not only to pay the 7 per cent. preferential dividend secured to the "A" shareholders, but to wipe off that considerable amount of £121,000; so that, in fact, we emerge from the protected period having paid 7 per cent. for the whole of the 10 years, and as regards this present year, with the addition of 3 per cent. out of the profits. The balance of profit you will see, on turning to the profit and loss account, amounts to £86,642, and you will also see how we propose to appropriate it. When we began the year the balance of arrears on the cumulative "A" shares amounted to £8,261—that was the last remnant of the £121,000 which we began with five years ago. That, of course, had to be got rid of, and it was done by an interim payment at the end of the first six months, in addition to which we paid 3½ per cent. for the half-year ended December 31st—£12,371—on the "A" shares. Now we propose to make up the 7 per cent. preference dividend which the "A" shares are entitled to, and for the first time in our history, the position of the "B" shares is to be taken into account in regard to dividend. This £117,000 worth of shares represents the interest of Mr. Edison and his friends as the purchase price of the patents, and the founding expenses of the Edison Company, and is held subject to this—that they participate to the extent of one-fourth in any profit of the undertaking after we have satisfied the 7 per cent. preference claim of the "A" shares. I hope the participation of the "B" shares in our profits will endure. We carry over the very considerable sum of £39,448; but, seeing what is before us, we think we should have a strong reserve, and the directors have had no hesitation in what they conceive to be their duty to you in recommending a 10 per cent. dividend, instead of one which, of course, was possible if we had trenched further on the profit of the year. What we have to consider is whether the profit of the year, as represented in these figures, is likely to be maintained in face of the competition which, at all events, may be considered as likely to be tolerably severe. We shall not escape the inevitable, and must endeavour to hold our own. We think that, with our good organisation, a large connection, strong reserve, and a good name, we shall be able, if not to see such large results as during the protected time, at all events to retain sufficient business to make the dividend a very fair and reasonable one. What it will be no man can tell; but what I do mean is, that we shall have to keep our eyes open and put our best foot forward in the next two or three years. With that view we have become manufacturers as well as lamp makers. For a very long time we were so bitten by the errors of the two companies—the Edison and the Swan—in entering upon installation business and contracting for supplies of light and so forth, that we determined not to touch installation work until we saw our way very clearly; therefore, for a number of years we pursued the humble *rôle* of lamp makers. Latterly we have merged into the business of manufacturers of appliances for fitting and installation in houses and elsewhere, and, although the lamp patents expire in November, we have other valuable patents in connection with the appliances which are already bringing in a considerable annual income, and which extend over a tolerably long term of years. In respect of these patents, for holders and so forth, we have continued to manufacture them for ourselves, and charged ourselves the same royalty as we charge our licensees, and we have licensed a large number of leading firms in the gas-fitting, lamp-fitting, and brass-founding business, who are competing with us in a sense, but are bound to sell at the same price as we do, and are paying us a royalty. Of course, this business is of the character of many others: the fixed charges are considerable, and are not influenced by the number of lamps sold. The price of the lamp is car-marked, and you can produce a large number at a rate per lamp considerably less than a smaller number, and we have attained that position in which we can produce lamps as cheaply, certainly, as anyone in this country, probably in Europe. The reputation of the lamp seems to be established. I daresay when the competition comes on us we shall have lamps from all parts—Germany and the Continent generally. We know pretty well what these lamps are, and have a knowledge which enables us to measure possibilities, and although, no doubt, the number of lamps sold may in the first moment of this competition be affected, more or less, we must look to the general development of the business, and to our being able to hold our own in the total output of lamps, which must, year by year, greatly increase, because only quite recently the electric light business seems to have improved. One has the opportunity of reading in the papers the speeches of gentlemen connected with electric lighting companies, and we have been interested to learn in that way how the Westminster, the St. James's, the Metropolitan, and other companies have all largely increased the number of their lights. All this means the rapid multiplication of lamps. When the time comes we must endeavour to hold our own relatively to the general advance in this business, which, I foresee, will be considerable during the next few years. There is another thing to which I should like to call your attention. The gross income, including the stock, you will see is £240,271, as against £212,048 last year—an increase of £28,223. The gross expenses have been £153,629 compared with £137,236, or more by £16,393, leaving a net profit of £11,831 in addition to that of last year. That £16,000 is rather a large increase in the expenditure; but this year, for the first time, we have had to bear the burden of the establishment of a number of depôts. As our business extends, people who live in the great centres of industry will probably get tired of drawing their supplies from the factory at Ponder's End; therefore, we were determined to try the experiment of a London depôt, and we opened one in Parliament Street, Westminster, where we have done an extremely good business. We have also opened another at 110, Cannon Street, with like satisfactory results. In addition to the two depôts in London, we have opened one each at Birmingham, Cardiff, Liverpool, Leeds, Newcastle, Hull, Dundee, Glasgow, Belfast and Dublin, and we are doing business in all those places. Now I should like to say a few words with reference to our solid asset, and by that I mean our tangible property. The preferred or "A" capital of the company is £353,478, which has a cumulative claim of 7 per cent. before the "B" capital gets anything. It takes £24,743 to pay that 7 per cent. Our capital is £353,478 of subscribed money, and £117,820 in deferred shares, in virtue of the benefits accruing from our patents. As, however, these patents are on the point of expiring, not much value can be attached to them for the future; but, as far as the holders of that £117,820 go, they are entitled to a quarter of anything over 7 per cent. on the "A" shares. I hope they will get their quarter, and I think there is a probability that they will get something. But we are more concerned for the people who found the £353,478. Now, of that amount we have got a solid asset in the nature of freehold property, plant and stock, debtors, and consols to the extent of £200,000. Of course, that is the value as a going concern; but we have written off these items considerable sums from year to year. We have, then, £200,000, and the question now is whether our experience, our capacity to supply the demand, and our trade mark is worth the balance. You are as capable of judging that as I am. I am sanguine enough to believe it is, and I think we need be under no apprehension that our venture will cease to be certainly a reasonably profitable one, and probably a very profitable one, because, with the extension in the number of lamps sold, we shall speedily retrieve the loss which may ensue upon the price of them, when we emerge from the protected period. I do not know whether anyone will be curious upon the subject of accounts; if so, I shall be happy to enlarge upon them. But I think they speak for themselves. There are many competent people present to look into them, and suggest questions which present themselves to their minds, and if there are any who wish to do so, I shall be happy to answer them. I now move the adoption of the report.

Major SAMUEL FLOOD PAGE seconded the motion, which was carried without discussion.

The CHAIRMAN next moved: "That a dividend be, and is hereby, declared on the 'A' shares of the company of 4s. 0½d. per share on the 89,261 ordinary shares, £3 paid; of 6s. 8½d. per share on the 5,000 £5 fully paid shares allotted to the Edison Electric Light Company, Limited; of 5s. 0½d. per share on the 12,139 £5 fully paid shares allotted to the Swan United Electric Light Company, Limited; and of 3s. 2d. per share on the 'B' shares of the company, being, with the interim dividend paid on March 14th, 1893, a payment on the 'A' shares of the company of the balance of arrears of cumulative preferential dividend, and of 10 per cent. in respect of the year ended June 30th, 1893, and on the 'B' shares of the company 3 per cent. in respect of the year ended June 30th, 1893—all to be distributed in accordance with the provisions of clause 87 of the articles of association, income-tax free."

The motion was unanimously carried.

Mr. KILLINGWORTH HEDGES said he had heard that negotiations were proceeding for an amalgamation of the Swan United Company with this company, and he should like to hear if there were any chance of the interests of the two companies being brought together. He should also like to know whether such an amalgamation would lead to economies.

The CHAIRMAN said the board had felt the importance of that amalgamation from year to year, and it had become accentuated as the period of the expiration of the patents approached; therefore they had given their attention to the subject during the year. A proposition had been formulated, and substantially, he understood—for, being chairman of both companies, he had stood out of the negotiations—agreed upon, upon which the Edison and Swan would take over the remnant of the business of the Swan Company. There were one or two internal matters which would, however, have to be submitted to the shareholders of both companies before the amalgamation could be carried out. One of the objects of the fusion would certainly be to promote economy of administration.

On the motion of the CHAIRMAN, seconded by Mr. HEDGES, Major Flood Page was unanimously re-elected to his seat on the board, and Mr. Shelford Bidwell, F.R.S., was similarly reappointed, on the motion of the CHAIRMAN, seconded by Mr. CUTHBERT QUILTER, M.P.

Messrs. Welton, Jones & Co. were reappointed auditors to the company, and the proceedings then closed with a vote of thanks to the Chairman.

Crompton & Co., Limited.

THE fifth annual general meeting of this company was held last Monday at Cannon Street Hotel.

Viscount EMLYN, who presided, in moving the adoption of the report, said that although they met with a diminished dividend, the directors felt quite justified in congratulating the shareholders upon the progress in the position of the company. The turnover of business showed a satisfactory increase over the previous year, and the gross profits on trading showed an increase of nearly £3,800. That progress had been made in spite of the severe commercial depression which had affected more or less all classes of business, and consequently checked the receipt of orders for their goods. Australia, through their affiliated company, formerly had been one of their large customers, but this year that country had taken very little from them. There are now, however, signs that that trade was likely to improve, the orders booked during the past three months being very nearly equal to those for the whole of the previous year. The outlook from South Africa also was promising. During the past year the cost of manufacturing goods at Chelmsford works had again been considerably reduced, and in fact, as regarded economy of management, the directors felt that they had every reason to be satisfied with the progress made in that direction. Unfortunately the year had suffered from very exceptional and unforeseen expenses, the principal of which were those attending the temporary arrangements consequent on the breakdown of the boilers at the Chelms-

ford works. The water supply there, though expensive, was unsatisfactory in quality, and the boilers, when the heavy pressure of the town lighting came on last winter, gave out altogether, and before new ones could be got to take their place, temporary boilers had to be hired and put into position at great expense in order to keep the works and town lighting plant going. Since that trouble the directors had got new boilers into position with water purifying plant, and substantial savings are now being made in that department. Another item of expenditure beyond the normal amount had been the cost of advertising and exhibitions. That account was being closely watched, so as to effect considerable reductions during the current year. The extraordinary general meeting of the shareholders last October sanctioned the nominal increase of the capital of the company to £300,000, the cost of registering that capital, and the expenses of issuing the prospectuses and advertising, had been temporarily charged to a suspense account, and would be written off in equal instalments in about three years. Since the last meeting, 2,781 preference shares and 1,928 ordinary shares had been placed. The list of applications for debentures had also been closed, and the committee of the Stock Exchange had granted a quotation in the official list for those securities. That was evidence that all formalities had been properly complied with. The stock-in-trade showed a considerable increase over previous years. That was a satisfactory feature, the increase consisting as it did mainly of the finished parts of machines, which enabled the company to make quick delivery, and that fact was an important thing in securing orders. The item of trade debtors showed an apparent decrease, but that was due to the transfer of the Chelmsford lighting account. The profit and loss account, for the reasons mentioned, showed a net profit of about £3,000 less than last year, and the directors did not therefore recommend the full dividend on the preference shares, and they felt sure that the shareholders would agree with them that that was the proper course to adopt. As far as the preference holders were affected, he would point out that their dividend was cumulative, so that the balance, which was 1 per cent. for the year, which was unpaid now, was carried forward to next year, and was a first charge after debenture interest on the future profits of the company. The board had every confidence in the future; the works at Chelmsford and Lillie Bridge were in first-rate order and well equipped. The company had a good staff of engineers and officials, most of them old ones, and was served by an excellent body of workmen. It would be gratifying to them to know that the "Crompton" arc lamp had been so improved by the efforts of the staff, that it now held the position of being the best and cheapest in the market, and that very considerable orders had been received for those lamps. The directors had done the very best they could for the shareholders.

Mr. R. E. B. CROMPTON seconded the resolution, and said they did not want to put forward lame excuses for the decreased dividend. They had not had so good a year as they had hoped to have. The causes, he thought, had been beyond their control, the general bad trade had had a great deal to do with it, and individual bad luck as well. He could corroborate every word the chairman had said. They, as managing directors (he and Mr. Albright), were very sorry for the shareholders' sake that the dividend was as it was, but they were also very sorry for their own sakes, as it had, of course, affected them very heavily. Since the beginning of the financial year there had been a steady and continuous decrease in the expenses under the head of cost of power at Chelmsford. Managing directors were affected more than anyone else, and they therefore had the strongest spur to see everything put right as quickly as possible.

Several shareholders having criticised the report, the resolution was put to the meeting and carried unanimously.

The dividend on the preference shares was next proposed and agreed to.

Resolutions re-electing Mr. Drummond as director, and Messrs. Duncan as auditors, followed by a vote of thanks to the chairman, closed the meeting.

Globe Telegraph and Trust Company, Limited.

THE twentieth ordinary general meeting of the Globe Telegraph and Trust Company, Limited, was held on Thursday last week at Winchester House, under the presidency of Sir John Pender, M.P.

The CHAIRMAN, in moving the adoption of the report, said the net revenue for the year ended July 18th, after the payment of expenses, amounted to £188,931, as against £192,243 last year, or a decrease of £3,312. This decrease, which was but a small one, considering the general depression which had existed during the past year, was accounted for by the fact that they had received somewhat reduced dividends from four or five of the companies in which they held investments. On the other hand, there were two or three of the companies which had given them a better return this year than they did in the previous year. This enabled the directors to recommend the payment of a dividend on the ordinary shares of 4⅞ per cent. for the year under review. Last year they were able to pay 4½ per cent., or 6d. more than they proposed to pay this year. The average dividend which the company had paid since its formation in 1873 was 4⅝ per cent., so that the present dividend was above the average, and therefore it was not disappointing. The Brazilian Submarine Telegraph Company had paid them £1,182 less than last year, the Telegraph Construction and Maintenance Company £2,188 less, and the Western and Brazilian Telegraph Company £897 less; while the West African Telegraph Company had not been able to make any return in the way of dividend during the past year. On the other hand, they had received £1,092 more from the Anglo-American Telegraph Company and £1,025 more from the Submarine Cables Trust. The return on the other investments was practically the same as last year.

The MARQUIS of TWEEDDALE seconded the resolution, which was carried unanimously.

Anglo-American Telegraph Company, Limited.

THE half-yearly general meeting of the Anglo-American Telegraph Company, Limited, took place on Friday last at Winchester House.

The Marquis of TWEEDDALE, in moving the adoption of the report, said that the receipts had amounted to £146,885, an increase of £367, and the best the company had experienced for some time. The beginning of this month was unsatisfactory, but the latter part of it had placed the receipts a little above what they were last year. The working expenses showed an increase of £818, mainly due to the loss caused by fire at St. John's, and to the increase in salaries. The net result had been an interim dividend of 12s. 6d. on the ordinary stock, not a very large return, but it was paid on a stock which had been heavily watered to the extent of about 50 per cent. The proprietors had no doubt noticed with a certain amount of satisfaction that the reserve fund now stood at £1,007,261, or £7,000 above the million of which they had often talked. Whether this sum could be made available for dividend purposes must depend on the freedom from further interruption, and on the speed and economy with which the present interruptions were being repaired. The Brest cable had always been a disappointing one, and had cost in repairs, since it came into their possession, about £214,000. The record of the 1874 cable was a better one. It had only been interrupted on two previous occasions, and both times near the shore. The present interruption, however, was a somewhat serious one, being in deep water and a good many miles from the other side. Even if these cables were speedily repaired the cost would be considerable, and if time and cable were needed he could hold out little or no hope of any portion of the reserve fund being made applicable to dividend purposes.

The report was unanimously agreed to.

Direct United States Cable.

THE thirty-second ordinary general meeting of the Direct United States Cable Company, Limited, was held on Friday last at Winchester House, under the presidency of Sir John Pender.

The CHAIRMAN, in moving the adoption of the report, said the revenue for the half-year ended June 30th last, after deducting out payments, amounted to £40,836, and the working and other expenses to £18,898, leaving a balance of £21,938 as the net profit of the half-year. This, with £3,129 brought forward from the previous half-year, made a total of £25,067. Three quarterly interim dividends of 3s. 6d. each per share, amounting to £31,872 15s., had been declared and paid during the financial year, and a final payment of 3s. 6d. per share was now proposed, making, with the three interim dividends, 3½ per cent. for the year, being a total distribution of £42,497. After transferring £3,000 to the reserve fund account, which now stood at £267,415 12s. 7d., the balance of £819 2s. 4d. on the revenue account was proposed to be carried forward. The revenue, as compared with that of the corresponding period of the previous year, showed an increase of £1,822. Considering the general depression which had prevailed, this result must be regarded as satisfactory.

The report and accounts were unanimously adopted.

South Staffordshire Tramways Company.—The meeting of this company, held at Birmingham on Thursday, last week, Mr. Carruthers Wain presiding, was characterised by noisy proceedings. The chairman declared the meeting informal, as a notice had been circulated abandoning it. An outburst of discontent ensued, a shareholder stating that the procedure was most improper. The Chairman said he was advised that the course adopted was quite the usual thing; and, after wordy warfare, the meeting adjourned.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee to allow the following securities to be quoted in the Official List:—National Telephone Company, Ltd. —Further issues of 25,730 ordinary shares, Nos. 458,868 to 484,597; 28,284 five per cent. non-cumulative third preference shares, Nos. 90,951 to 119,234; £198,540 four-and-a-half per cent. debenture stock.

Cuba Submarine Telegraph Company.—The directors, after providing for the dividend on the preference shares, recommend a dividend on the ordinary shares at the rate of 8 per cent. per annum for the half-year to June 30th, tax free.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 30th, 1893, amounted to £822; week ending July 31st, 1892, £735; increase £87; total receipts for half-year, 1893, £3,425 corresponding period, 1892, £3,021; increase £404.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of July were £3,000; as compared with £3,194 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of July, 1893, amounted to £1,656, against £1,684 in the corresponding period of last year.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 28th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,784.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, July 26th.	Closing Quotation August 2nd.	Business done during week ended August 2nd, 1893. Highest.	Lowest.
195,100£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,134,640£	Anglo-American Telegraph, Limited	Stock	49½ — 50½	48½ — 49½xd	48½	...
2,932,680£	Do. do. 6 p. c. Preferred	Stock	93 — 94	91½ — 92½xd	93½	91⅝
2,876,140£	Do. do. Deferred	Stock	9½ — 9⅝	9 — 9½	9⅝	9⅜
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜ — 12⅝	11⅜ — 12½	...	...
36,400£	Do. do. 5 p. c. Bonds	100	101 —104	99 —103 xd	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞ — 3⅛	3 — 3½	3 1/16	2⅞
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2⅛	2 — 2⅛	2⅛	2 1/16
125,000£	Do. do. 4½ per cent. Debenture Stock	Stock	107 —109	107 —109	...	...
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	5 — 5⅛	5 — 5⅛xd	5 7/16	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000£	City and South London Railway	Stock	35 — 37	35 — 37	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	10⅜ — 11¼	10⅜ — 11¼	...	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12½ — 13 xd	12½ — 13	12⅜	12 11/16
$7,716,000	Commercial Cable, Capital Stock	$100	138 —142	138 —142	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅛ — ¼	⅛ — ¼	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	4⅛ — 5¼	4⅛ — 5¼	5	4⅞
50,000£	Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	102 —105	... ...	...	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	18½ — 19½	18½ — 19½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 12	11⅜ — 12	12	11⅞
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15 — 15½	14⅜ — 15 xd	15	14⅜
70,000	Do. 6 p. c. Preference	10	16½ — 17	16¼ — 16⅜xd	16⅜	...
105,900£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	106 —109 xd	...	...
1,294,100£	Do. 4 p. c. Mortgage Debenture Stock	Stock	112 —115	112 —115	114½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15½ — 15⅝	15⅛ — 15⅜	15⅜	15
70,600£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	104	103½
250,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	103	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	113 —116	111 —114 xd	...	...
108,700£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900	100	101 —104	101 —104	...	...
146,800£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	...	101 —104	101 —104	...	...
300,000£	Do. do. to bearer, Nos. 2,344 to 5,500	100	102 —105	101 —104 xd	...	...
49,900	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	10	1⅜ — 2¼	1½ — 2	...	...
19,900	Electric Construction, Limited, Nos. 101 to 45,100	5	... ...	... ...	...	...
100,000	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	2	⅛ — ¼	⅛ — ¼	...	...
91,195	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	¼ — ⅜	⅛ — ¼	...	...
67,385	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅛ — ⅜	⅛ — ⅜	...	...
20,000	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	5	1 — 2	1 — 2	...	...
180,227	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	10	9⅜ — 10	9⅛ — 9⅜xd	9⅜	9 1/16
180,042	Globe Telegraph and Trust, Limited	10	15⅛ — 15⅜	15⅛ — 15⅛xd	15⅜	15⅜
150,000	Do. do. 6 p. c. Preference	10	19½ — 20	19½ — 20	...	...
200,000£	Great Northern Tel. Company of Copenhagen	100	105 —108	105 —108	...	...
12,134£	Do. do. 5 p. c. Debs. (issue of 1883) ...	10	4½ — 5½	4½ — 5½	...	...
9,600£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	6 — 7	6 — 7	...	...
50,000	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	21½ — 22½	21½ — 22½	...	...
200,000£	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	100	102 —104	102 —104	...	...
17,000	Do. do. 4½ p. c., Deb., 1896	25	39 — 42	39 — 42	...	...
11,334	Indo-European Telegraph, Limited	10	2½ — 3½	1½ — 2½	...	...
30,000	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	5	4 5/16 — 4 7/16	4 5/16 — 4 7/16	4 7/16	4 5/16
10,000	†Liverpool Electric Supply, £3 10s. paid	5	6⅜ — 6⅝	6⅜ — 6½	6 7/16	5⅝
37,548	Do. do. fully paid	10	4 — 6	4 — 6	...	...
100,000£	London Platino-Brazilian Telegraph, Limited	100	107 —110	107 —110	...	...
49,900	Do. do. do. 6 p. c. Debentures	10	6 — 6½	5⅞ — 6¼	...	...
50,000£	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	...	102 —105	102 —105	...	...
15,000	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40 ...	5	1½ — 2½	1½ — 2½	...	...
28,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	3 — 4	3 — 4	...	...
458,867	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	4⅜ — 4⅝	4½ — 4⅝xd	4⅝	4½
15,000	National Telephone, Limited, Nos. 1. to 438,984	10	14⅜ — 15½	14½ — 15 xd	...	...
15,000	Do. 6 p. c. Cum., 1st Preference	10	14½ — 14⅝	14 — 14¼xd	41 1/16	...
90,950	Do. 6. p. c. Cum. 2nd Preference	5	5⅜ — 5⅝	5¼ — 5⅜xd	5 5/16	5¼
726,477£	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	...	110 —114	111 —113	113	112½
48,800£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	10	... ...	... ...	...	...
6,451	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	5 — 6	5 — 6	...	...
220,000	Notting Hill Electric Lighting Company, Limited, fully paid ...	1	⅛ — ¼	⅛ — ¼	...	...
100,000£	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	100	100 —103	100 —103	...	...
11,802	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	8	4½ — 5½	4½ — 5½	...	...
18,680	Reuter's Limited	5	6½ — 7	6¼ — 6⅝	6⅝	6⅜
20,000	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8 — 8½	7⅞ — 8¼xd	7⅞	...
3,381	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	Cert.	118 —123	116 —121	122	...
78,949	Submarine Cables Trust	5	2 — 2½	2 — 2½	...	...
37,350	Swan United Electric Light, Limited ... ... (£3½ only paid)	12	33 — 35	33 — 35 xd	35	34½
150,000£	Telegraph Construction and Maintenance, Limited	100	101 —104	101 —104	...	...
58,000	Do do. do. 5 p. c. Bonds, red. 1894	5	2 — 2½	2 — 2½	...	...
146,370£	United River Plate Telephone, Limited	Stock	90 — 100	90 —100	...	...
15,609	Do. do. 5 p. c. Debenture Stock ...	10	5½ — 6½	5½ — 6½	...	...
260,900£	West African Telegraph, Limited, Nos. 7,501 to 23,109	100	99 —102	99 —102	...	...
30,000	Do. do. do. 5 p. c. Debentures	10	3 — 4	3 — 4	...	...
150,000£	West Coast of America Telegraph, Limited	100	97 —101	97 —101	98	...
64,242	Do. do. do. 8 p. c. Debs., repayable 1902 ...	15	7 — 7½	7 — 7½	7⅛	...
33,129	Western and Brazilian Telegraph, Limited	7½	5⅝ — 6½	5⅝ — 6¼	6	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	1½ — 2	1½ — 2	...	...
178,200£	Do. do. do. 5 p. c. Deferred	100	106 —109	103 —106 xd	107	...
222,700£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	103 —106 xd	...	...
88,321	Do. do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	10	1½ — 1⅝	1½ — 1⅝	...	...
34,563	West India and Panama Telegraph, Limited	10	10½ — 11	10½ — 11	10½	...
4,669	Do. do. do. 6 p. c. 1st Preference ...	10	9 — 10	9 — 10	...	...
80,000£	Do. do do. 6 p. c. 2nd Preference ...	100	105 —108	105 —108	...	...
$1,214,000	Do. do. do. 5 per cent debentures (1917) No. 1 to 1,000	$1,000	120 —125	120 —125	...	...
169,000£	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	100	100 —103	100 —103	...	...
99,900	Do. do. 6 p. c. Sterling Bonds	5	5½ — 5⅝	5 — 5½xd	5 7/16	5 5/16
	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...					

‡ Unless otherwise stated all shares are fully paid.

† Quotations on Liverpool Stock Exchange.

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5½—6.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1½—2½.—Founders' shares, 200—225.—House to House Company (£5 paid) 1¼—2¼.—Do. 7 per cent. Preference of £5, 5—5¼.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5¼—5⅝, 1st Preference Cumulative 6 per cents., £5 (fully paid) 6—6¼.—Manchester, Edison and Swan Company, £9 (£1 paid), ¼—½.—Queen Anne's Mansions Lighting and Heating 6 per cent. £10 Debentures, 101—103.

Bank rate of discount, 2½ per cent (June 15th, 1893).

EFFECTIVE ALTERNATING CURRENTS AND ELECTROMOTIVE FORCES.*

By A. E. KENNELLY.

SINCE, in dealing with alternating current circuits, the terms "mean current," "square root of mean square," and "effective current," are sometimes not clearly understood, a few remarks upon the subject may not be unacceptable.

Suppose that in a circuit we have a current alternating, between the limits of 10 ampères positive and 10 ampères negative, say 200 times in a second. The mean or numerical average current strength will be some value between 0 and 10, depending upon the shape of the current wave. With a simple zig-zag wave, the mean current would be 5 ampères, for semi-circular waves 7·854 ampères, and with sine waves 6·367 ampères.

But in the most important practical applications of electric currents, the effect depends upon the square of the current strength. The rate of developing heat in a constant resistance is a prominent instance, and incandescent lamps may be practically included in the same category. When the current through such a resistance is doubled, the rate at which the heat is generated therein is quadrupled. If the current periodically alternates or fluctuates, the same quantity of heat will be developed in a given interval of time (including many cycles), if the average square of the alternating current is equal to the square of the uniform continuous current strength. Just what maxima the cycles will reach when this condition is maintained will depend upon the shape of the current wave; but if the wave happens to be a sinusoid, with a maximum of 10 ampères, whose square is 100, the mean square over the cycle is just half this maximum square, or 50, and the heating effect of this alternating current would be equal to that of a continuous current whose square was 50; that is, whose strength was 7·07 ampères.

The "effective" strength of any fluctuating or alternating current is thus the square root of its average square; and if we know this effective strength, we know the heating power of the current, without requiring any knowledge of the wave shapes.

The mean strength of a current measures, then, the quantity of electricity that would flow through the circuit in a given time, without regard to direction. The "effective current," or square root of the mean square, measures the thermic activity that the current will develop in a resistance. The mean strength of an alternating current would be indicated by a D'Arsonval galvanometer if the waves were all "rectified," or delivered to it in the same direction with the aid of a commutator. The "effective" current strength would, on the other hand, be indicated by an ammeter of the dynamometer type, with or without rectification, since the deflections of such instruments are independent of the direction, but proportional to the square of the traversing current's strength. If this square fluctuates they point out the average square.

Similarly, the "effective" voltage of a periodically varying E.M.F. is equal to that uniform continuous E.M.F. which, applied to a simple non-inductive resistance, would generate therein the same amount of heat in a given time sufficiently long to include a number of cycles and obtain a fair average. Since the thermal activity of an E.M.F. applied to a fixed resistance is proportional to the square of the voltage, the effective value will be the square root of its average square.

The term "effective," chosen by the Paris Congress of 1889, may be understood as "effectively equivalent in thermal activity."

All alternating current voltmeters and ammeters are in practice calibrated to "effective values." By this means, an incandescent lamp, which is brought to full illumination on a continuous current circuit by half an ampère, or by 100 volts, will be brought to full illumination by these same quantities of current and voltage on an alternating current circuit, no matter what the shape of wave, assuming, of course, as experiment shows we may, that the "skin effective" and the inductance in the lamp filament are negligible. If, on the other hand, alternating current apparatus were calibrated in "mean" values, the voltage or current necessary to supply lamps at normal candle power would not only differ from the corresponding continuous current values, but would also depend upon the shape of the alternating waves.

* The *Electrical World*.

ELECTRIC LIGHTING OF RUSSIAN MEDICAL SCHOOLS.

[FROM OUR OWN CORRESPONDENT.]

THE Imperial Medical Academy of St. Petersburg has recently started quite a large system of electric lighting in the hospital. Podobedoff, of St. Petersburg, a name somewhat unfamiliar to English ears, is responsible for the work. High tension currents with transformers are used. The chief reasons which led the authorities to adopt this system were that the station might be situated on the banks of the Neva, thus ensuring good water supply, and that distant offices of the War Department might eventually be provided with the electric light.

The greatest distance of the station from any point to be illuminated is 19,000 metres, or about 2 wersts. The highest permissible fall of pressure in the high pressure mains is 2 per cent. The steam is generated in tubular boilers by Fitzner and Gamper, of which three are set up, and the foundation is prepared for the fourth boiler. The heating surface of each boiler is 160 square metres.

The engine house is constructed for three engines, and coupled direct to the dynamos. Two of them are already set up, and the foundation is laid for the third. The engines are triple expansions constructed for twelve atmospheres, but safe at thirteen atmospheres, when they develop an efficiency of 300 H.P. The engines are provided with a very sensitive regulator so that they run very evenly; they make 170 revolutions per minute. Alternating current machines by Ganz & Co., of Budapest, of a capacity of 180,000 watts, are used. The exciter is carried on a prolonged shaft of the alternating current machine.

The maximum number of lights burning at present is 3,580 glow lamps at a candle power ranging from 16 to 100, in addition are 12 arc lamps. Overhead mains of bare silicon bronze are used. Only in crossing the streets are the wires insulated, and then with a slight protective sheathing suspended at slight distances to steel cables hung above them to prevent the wire from falling upon the street in case of breakage.

The line is insulated from the buildings by oil insulators. The high pressure mains pass direct into transformers of Ganz's Zipernowski, Deri-Blathy system, which are placed in locked closets in the houses. The secondary mains are carried in the ordinary manner from the transformers to the lamps in the interior of the buildings. There are now 25 such transformers of different sizes.

Hitherto 250,000 roubles have been expended by the War Department for the entire plant. The working is entrusted for six years to the firm Podobedoff for the payment of 1 kopek (·38d.) per ampère hour.

AUTOMATIC MERCURY CUT-OUT.*

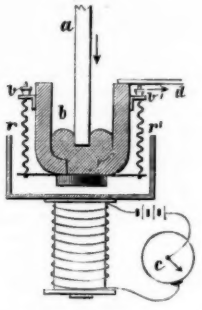
M. FELIX LECONTE, from the University of Ghent, after having described before the Scientific Society of Brussels the instruments at present in use, explained and illustrated some new inventions for breaking an electric lighting circuit at a given moment.

One of these was a mercury interrupter. It consists of a cylindrical vessel containing the mercury closed at the bottom by a piece of iron held against the edges of the cylinder by two springs; this piece of iron is fitted with leather so as to close the cylinder hermetically and prevent any leaking of the mercury.

The current of the lamps to be extinguished passes through the rod, *a*, and is continued along the wire, *d*, which is soldered to the cylinder. Under the piece of iron is an electro-magnet. The wire of this electro-magnet is connected with a battery, the circuit of which is closed upon the clock

* *L'Electricien*.

at the works at the hour required. The current passes through the small hand and through the movable contact, *c*, in the electro-magnet. The iron armature is attracted and the mercury flows out. The lighting circuit is broken, and cannot be re-established by any accident. The mercury is received into a cup placed on the electro-magnet. To



relight the lamps all we have to do is to pour the mercury back into the cylinder. When the apparatus is at work the mercury falls rapidly. The breaking spark is instantaneous, and, consequently, not dangerous.

Remark.—In the figure *r* and r^1 are the springs, ensuring the contact of the armature against the cylinder; *v* and v^1 are the regulating screws.

ELECTRICITY IN MARITIME OPERATIONS.

ALTHOUGH few electrical engineers were present, the subject of electricity in maritime operations formed a not unimportant part in the fourth section of the International Maritime Congress, whose meetings took place on July 18th, 19th, 20th, 21st and 22nd, in the halls of the Institution of Civil Engineers, Westminster.

Lord BRASSEY in his opening address referred to the improvements in the construction of harbours and the lighting of coasts.

We will only briefly refer to the most important points touched upon in the fourth section, and particularly as to the use of electricity for lighthouse and off coast illumination.

On the Tuesday a paper by M. C. Ribière on "Compressed Air Fog Signals" was read, after which Mr. J. Kenward presented a memoir on "Ship Lights and Collisions." The author advocated (1) the absolute common increase of the power of all the apparatus, side, mast, anchor and stern lights; and (2) the provision of such an illuminant in the coloured side lights as would nullify the reduction of power through colour, and so render the emerging beams of all the lights approximately equal in intensity. In this manner the three lights of a moving steam vessel, or the two lights of a moving sailing vessel, may be seen at the maximum distance possible to their position and elevation, and may afford an unmistakable signal of the course the vessel is keeping. Mr. Kenward said that electricity was the only convenient means to effect this, and he had arranged an incandescent lamp of 100 C.P. for the red light, and another of 200 C.P. for the green light, together with, for the latter, a particular tint of green glass which had been adopted as a standard by the Board of Trade. In this condition the side beams were equal in intensity with the mast-head beam. This system was first adopted on the *Roslin Castle*, and it had been improved upon since its first introduction.

FLASH LIGHTS.

A paper by M. André Blondel (Ingenieur des Ponts et Chausées), who was unable to be present, was read on Wednesday, "On Feux-Eclairs, and the Physiological Perception of Instantaneous Flashes." The author stated that the apparatus termed *feux-éclairs* for producing flash lights, designed by M. Bourdelles, was well known, and that it was described in detail in the memoir on lighting apparatus presented by the Service Central des Phares de France to the Chicago Exhibition. This new type of lens now enabled us to realise a luminous power hitherto unknown, without increasing the intensity of the source of light or the expense of construction. Many engineers must already have had their attention directed to the new methods adopted, particularly in regard to the system of rapid rotation over a mercury bath, and to the simple and original form of the lens, reduced to four or two panels, or even to one only. But, apart from ingenious peculiarities of construction, this apparatus was perhaps still more interesting on account of the new principles which governed its design, and which depended upon certain little known physiological phenomena. The author then explained these phenomena and the theory of the flash lights. He then proceeded to state that numerous experiments and the detailed investigation made by the Nautical Commission, formed in 1886 to examine the different questions relative to electric lighting, had shown that the continuous attention of the navigator, and easy determination of bearings could not be secured except by producing flashes at least every five seconds. That figure had, therefore, been adopted by M. Bourdelles for his flash lights. Coming to consider electric flash lights, the author said that we could not think of rigorously proportioning the diameter of the source of light to that of the lens, for that would lead to very considerable sizes for the carbons. These lights gave flashes which were sensibly uniform, and it was consequently easy to calculate their apparent power by the aid of Bloch's law. This point he explained in tabular form, and although many of the figures given in the table had only hypothetical value, interesting conclusions could be drawn from them. For the fourth order—that is, with a focal length of lens of ·30 metre—the light with two panels would only permit of the complete utilisation of the arc light up to 100 ampères; for the higher orders, four panels were more than sufficient, and as the period of the flash was much inferior to the maximum time, there was nothing to hinder a further increase in the intensity of the current, the quantity of additional light so produced being completely utilised. There was, then, at the present, no material impossibility in establishing electric flash lights giving not merely 8,000,000 candle-power with 100 ampères, but even 30,000,000 or 40,000,000 candle-power with currents of 400 to 500 ampères, such as were often discussed in England. As conclusions, the author established, among others, the following propositions: (1) Every source of light employed in a lens is capable of furnishing at each flash a quantity of light that only depends on its intensity, and the coefficient of vertical concentration of the apparatus, and on the interval between the flashes. This is fixed by considerations of a practical nature at the value of five seconds. (2) The electric flash lights could even realise the maximum utility at any distance. (3) The range that may be reached with electric flash lights is now no longer limited by the luminous intensity, but by the height of the tower that we should have to construct to render them available.

THE LUMINOUS POWER OF LIGHTHOUSE APPARATUS.

A paper was then read by M. Bourdelles (Inspecteur-General des Ponts et Chaussées, France), on "The Luminous Power of Lighthouse Apparatus." The author said that the determination of the luminous power of lighthouse lights—that is to say, the useful effects they produced on the eye of the navigator at different distances—had already formed the subject of numerous investigations in France and other countries. Up to the present time it had been agreed in France that the power was equivalent at any distance to that of a naked light of an intensity determined by photometric measurements. It had therefore been represented by a number of carcels decided from laboratory experiments. Those experiments had been sufficiently numerous to enable M. Allard to express by empirical formulæ the results furnished by the different apparatus in use in the Lighthouse Department. Dealing with luminous power as dependent upon weather, the author said that in foggy weather, when the want of transparency reduced the luminous range to a distance such that the navigator perceived the intrinsic brightness of the apparatus, it was necessary to increase that brightness as far as possible. It was to be noted, under these circumstances, that two lights of the same total brightness, but having different intrinsic brightness, would be unequal in range and visibility, although they might be equal in ordinary weather. From this point of view, the preference should be given to the arc lamp over the incandescent lamp, and to oil burners over gas; similarly to an electric lamp over an oil or gas lamp. For the same reason, with equal luminosity, the apparatus of small dimensions adopted in France for electric lights was superior to those of the second or third order preferred in other countries. It was an advantage in general to concentrate the pencil of rays emitted by the apparatus, and to reduce as far as possible its divergence, both in the horizontal and vertical plane. It was desirable to obtain the maximum of intrinsic brightness of the burner, since that of the apparatus, other things being equal, increased proportionally with it. The author said that it would appear to follow, from recent experiments made in England and France, that the intrinsic brightness produced by the voltaic arc in electric lighthouses remained constant whatever be the nature of the carbons, their diameter, or their distance apart; or whatever be the *régime* of the current. If that was so, he observed, the illumination obtained by the apparatus ought itself to be invariable, and the luminous power of an apparatus of a given order would be independent of the electric burner that illuminated it. The dimensions, as well as the intensity of the burner, would only affect the divergence of the pencil, and it would be immaterial, as regards the luminous range, whether more or less electrical energy was expended. On the other hand, the author remarked that photometric measurements of the most unassailable character made in great numbers in France, on the power of the electric light, contradicted those conclusions. He said that those measurements proved with the utmost certainty that the illumination varied as if the intrinsic brightness was itself variable and in conformity with the laws governing burners of other kinds. Until this anomaly was explained in a satisfactory way, "we must" he stated, "confine ourselves to established facts and hold it as proved, *at least in practice*, that lighthouse apparatus using electricity makes no exception to the general rule."

LIGHTING OF ESTUARIES.

On Thursday, Mr. W. T. Douglass, consulting engineer to the Trinity House, presented a paper on "The More Efficient Lighting of Estuaries and Rivers." He recommended the adoption of a system of beacons having a numerical basis, each beacon to have a number to be read with ease by the navigator. The beacons would be lighted either by compressed oil gas, or mineral oil. With regard to electricity, he said that in the form of incandescent lamps, it was a source of illumination which had many advantages where the central station was not too far distant from the beacon lights, and more particularly

where the central station was the property of port authorities. He stated that in New York Harbour the electric light was employed to define Gedney's Channel; there, incandescent lamps of 100 C.P., with three loops in the filament, were attached to spar buoys placed 1,000 feet apart. He concluded that everything possible should be done to facilitate the ingress and egress of commerce into and from inland ports.

HARBOUR LIGHTS IN ITALY.

A paper was next taken on "Harbour Lights, Buoys, and Beacons in Italy," by M. D. Lo Gatto. The author referred to the large adoption in Italy of Chance's (petroleum) occulting harbour lights, and light buoys and beacons, on the Pintsch compressed gas system. The illumination of beacons by incandescent lamps had, he remarked, recently been under consideration at Naples. Preliminary inquiries were made to ascertain if, in addition to the light installed in 1884 on the Las Puercas reef in the Bay of Cadiz, any similar lights were at present in use in Europe. It appeared, however, that the above-mentioned light was the only one of its class. The illuminating power in this case was obtained from two six-cell Daniell batteries, and the lamp was only of one candle-power. The Harbour Works Department at Naples had been desirous of studying a 12-volt Swan lamp of 3 C.P., and, accordingly, experiments were made with a sixth order light on the head of the San Vincenzo Pier, so as to test the optical result. This was found sufficiently satisfactory to make it probable that the combination of a sixth order lantern with a lamp of that power would, in many cases, be a sufficiently effective danger signal; but this optical result was deprived of much of its importance owing to the cost of renewals. The author thought that at present the electric lighting of beacons from primary or secondary batteries possessed no special advantages, and that as such excellent results were attained by the Pintsch system, the electric light might be set aside so far as those objects were concerned. In some cases, however, electric lighting might be practicable by conveying the current by cable from the shore, but the system would, according to M. Lo Gatto, be costly and involve greater precautions in protection of each end of the cable than might be justified by the object. The author concluded that the experience and study of the subject in Italy was that the lighting of beacons by compressed gas was the most reliable and practical system known at the present time.

ELECTRIC LIGHTING OF LIGHTHOUSES.

A paper was next presented on "The Electric Light of Lighthouses," by M. André Blondel, and dealing with experiments made by the Lighthouse Department of France. This paper was very lengthy, and was undoubtedly the most important read before Section IV. The author stated that the electrical apparatus of lighthouses using the voltaic arc had undergone no modification for many years. The machine of De Méritens, adopted in 1881 at the lighthouse of Planier, was now in use in almost all French and foreign establishments, and it gave good results. This type of machine had, however, in recent years, been severely criticised on account of its high price and antiquated type. They had been urged in different quarters to adopt more modern machines, and particularly those of the continuous current type. With a view to improve, if possible, its installations, the Lighthouse Department of France had undertaken, on the initiative of M. Bourdelles, Inspector-General, a series of systematic experiments since 1891 with both alternating and continuous current dynamos. In pointing out the conditions which the electrical apparatus must fulfil, the author mentioned that the generators, which might be driven by steam, hot air, Dowson gas or petroleum, must be strong, that the speed should be moderate and not exceed 800 to 900 revolutions, and that for the De Méritens machines it had been reduced to half of this rate. It was necessary that the intensity of the current should, according to the degree of transparency of the atmosphere, vary at least from 1 to 4, and in the French lighthouses the two extreme currents adopted were 25 and 100 ampères. With regard to arc lamps, the regulation of the arc so that it might occupy the focus of the apparatus, was effected by the aid of a screw that raised or lowered the two carbons simultaneously. The attendant had constantly to move this screw so as to bring the image of the arc or of one of the carbons to a mark traced on a table. It would be an advantage to effect this movement automatically, but efforts made in this direction had not been sufficiently satisfactory to lead to their continuation. The author next explained in very great detail the investigations made with continuous and alternating currents at the lighthouse establishment, and the considerations that weighed in favour of each solution. He then drew a comparison between the two. He stated that the continuous current dynamos were satisfactory from the point of view of strength and safety. They showed great economy in space and in cost as compared with the De Méritens machines, but the steadiness of the arc had only been obtained at the cost of a loss of efficiency, the efficiency at the terminals of the lamp having been reduced to 0·58 or 0·65 per cent. at the 25 and 50 ampère currents. On the other hand, the new alternators preserved the advantages of the De Méritens machines, although costing a little more than the dynamos, and they yielded electrical efficiencies of 74 and 80 per cent. at the two currents considered. It was, therefore, the alternators which appeared likely to replace the De Meritens machines without the necessity for any change in the remainder of the service. It must, however, not be forgotten that all the possible advantage obtainable from direct current dynamos had not yet been obtained, and that by a suitable compounding, a stability and efficiency superior to those hitherto obtained with these machines, might probably be realised. The author, in summarising his conclusions, states that: (1) The three elements constituting an electric lighthouse—machine, lamp, and optical apparatus—should not be studied separately, but taken together; in particular the lamp and the dynamo must be considered as two parts of one whole. (2) The best method to secure a good light service in ordinary conditions consisted in uniting in each establishment two similar machines, each capable of giving two currents of 25 and 50 ampères. The employment of currents above 100 ampères would not be justified in the French *feu-éclair*, or flash light apparatus. (3) The De Méritens magneto machine is particularly appropriate for this service, and the only serious objection to be raised against it is its comparatively high price. (4) The construction of a continuous or an alternate current machine, capable of replacing the magnetos, while preserving the same advantages, is not so easy a task as electricians are tempted to think it. The best proof of this is in the absolute or partial failure that has attended the efforts of manufacturers of repute in other countries as well as in France. (5) The attempts made have, nevertheless, shown the possibility of obtaining alternators suited to the service at a very moderate price, and of better efficiency than that of the magnetos, and perhaps at a later period, continuous current dynamos having similar properties might be obtained by using a special method of compounding. The alternators will give us the safety and regularity that continuous current dynamos will obtain with difficulty. (6) The comparative results obtained in the optical apparatus now in use show a considerable superiority in the alternate currents in respect of luminous efficiency. But these apparatus, not being the best suited to continuous currents, it may be suggested that an apparatus specially constructed for them might utilise the energy expended nearly to the same extent realised with alternate currents. However that may be, the latter exhibit at present advantages of all kinds, which are of a nature to justify the preference that has been given them for lighthouse lighting.

On Friday, the concluding day, three papers were read before this section. The first by Mr. D. A. Stevenson (engineer to the Commissioners of Northern Lights), was entitled "Notes on the Progress of Lighthouses." In the course of the paper, the author, in referring to the electric light, said that it was first exhibited from the South Foreland lighthouse in December, 1858, the lamp used being that of Duboscq. Among those who had improved the lamp were Staite, Serrin, and Berjot, the lamp generally in use combining the essentials of the two last named. Various powerful machines existed, but it had been found for lighthouse purposes, that a magneto-electric machine gave the best results, especially that of De Méritens. At present there were five electric lights on the coast of England, and one in Scotland. Between 1863 and 1885, eight electric lights had been established on the coasts of France, and the French authorities were still extending this system. The author said that the relative penetrative powers of gas, oil, and electricity during fog had formed the subject of careful photometric inquiry by Mr. H. B. Dixon, at the South Foreland experiments in 1885. The results arrived at were:—(1.) "That the oil and gas lights when shown through similar lenses are equally affected by atmospheric variations. (2.) That the electric light is absorbed more largely by haze and fog than either the oil light or gas;" but that "in all weathers and at all distances its penetration has proved superior to the gas and oil lights." These results had been confirmed in Scotland.

After some discussion, the second paper was taken. It was called a "Comparison of Gas and Electric Light in Lighthouses with Optical Apparatus of Large Dimensions," by M. D. Lo Gatto, engineer in the Italian Service at Naples. The author claimed a superiority for gas illumination over electric lighting, but there was very little information of practical value contained in the paper. This will be readily understood when it is mentioned that, after hearing the discussion on his paper, the author admitted that his views of the electric light had been considerably modified.

THE AZORES CABLE.*

WE recently called attention to the important commercial and political position held by submarine cables, a position which, better advised than ourselves, Englishmen have so thoroughly appreciated and turned to advantage.

The history of the Azores Cable is, unfortunately, a striking example of the foresight and the decision exhibited by the English in these matters, as compared with the short-sighted and hesitating policy shown by those who govern us.

The Azores group is the only spot in the Atlantic which English telegraph companies have not as yet seized upon. They, in the beginning of 1892, offered to the Portuguese Government to manufacture and to submerge, at their own cost, a cable between Lisbon and the Azores. As a consideration for this outlay, they asked for the exclusive right of cable-landing in the group. Their intention was to make immediate use of this right in connecting the Azores on the one hand with England, and on the other, with Madeira and the Bermudas, so as to establish in the latter place a central bureau for maritime news, which, in the case of war, would afford facilities of the greatest importance. There would, also, be thus created a new telegraphic route, for Brazil and the African coast, more easy of defence than the present line viâ Lisbon, whose security has given rise to some anxiety ever since the brutal seizure by the English in 1890, of certain territories in the Zambesia. England knows that Portugal can never forget this injustice.

In the month of February, 1892, a provisional contract in the terms proposed by the English company, was placed before the Cortes.

The French Government now perceived the importance of preventing the capture of the only point in the Atlantic where French enterprise might still establish a telegraphic system altogether independent

* From the *Politique Coloniale*.

of England. The Government requested the "Société Française des Télégraphes Sousmarins" to present at Lisbon, without further delay, certain proposals; these after a desperate struggle with the English companies, supported by their Government, finally succeeded in obtaining the rejection of the English contract, and in the signing on June 24th, of a French contract.

Meanwhile, the Technical Commission of Enquiry on Submarine cables instituted at the Postal Direction General in Paris, drew up a scheme for a submarine line to unite not only Lisbon with the Azores, but also France with America viâ Portugal and the Azores. The same official commission determined on the specificaton and price for the various types of cables required, arranged for all the necessary expenditure, determined the amount which could be guaranteed by the State, and finally made their work the subject of a bill presented to the Chambers on June 24th, 1892.

Two months prior to the expiration of the contract time allowed by the Portuguese Government, the date fixed upon being April 1st, 1893, the new Minister of Commerce, M. Siegfried, found fault with the contract prepared by the Technical Commission, asked that it should be again examined and revised, and did his utmost to ensure its rejection by the Budget Commission, succeeding in his purpose by the small majority represented by 10 votes against 8 in a body of 33 members.

Thus, without the sanction of a vote in Parliament, the Government, although bound in this matter by engagements with the Société Française des Télégraphes Sousmarins and with the Portuguese Government, abandoned the rights of landing which had been obtained with so much difficulty.

The consequences of this step are:—

1. The loss of 500,000 francs, the amount of the caution money deposited at Lisbon in guarantee of the fulfilment of the landing contract, the deposit being made on account of the State. One may ask by what arguments will the Government justify the credit it will be compelled to demand for the purposes of restitution?

2. The loss of landing rights in the Azores, which have been granted to the English Telegraph Construction and Maintenance Company, acting in concert with the Eastern and Brazilian Submarine Company.

3. A moral discredit which places France in the very worst position for obtaining fresh concessions, whether from Portugal or from any other country.

4. Finally, a moral and material injury to the Compagnie Française des Télégraphes Sousmarins, which had taken certain steps, had made considerable outlays, and had entered into various engagements on the faith of promises made by the Government.

We will not speak of those interests, of the greatest moment, which may suffer serious prejudice through the abandonment to the English of all the Atlantic telegraphic communications. The Government has, on this point, assumed a very grave responsibility.

The attitude of the Government throughout the whole of this affair has been most extraordinary, and its conduct seems to have been so utterly opposed to any attempt at safeguarding the rights and interests of France, that it can only be explained by the supposition that behind the scenes there are other considerations and influences to be reckoned with, powerful enough to determine the course of action which has been taken.

We have been assured that the French Government only humbled itself before England under the dread of the grave revelations which the London Cabinet threatened to make, and which would have thrown a curious light on matters closely connected with Panama affairs.

The Azores concession must have been the price of the silence held, in this question as in so many others, by that foreign government which keeps a hold upon the invalid of Bournemouth, upon his documents and his secrets.

We give this explanation, the only one which appears probable, under all reserve. We should be only too delighted if some reply were made, not merely in the form of a simple denial, which, after all, would prove nothing, but by a statement of the true reasons which could have induced the Ribot cabinet to place itself, in opposition to French interests, in the painful position we have above indicated.

THE LIGHT AND HEAT OF THE ARC.*

By M. JULES VIOLLE.

THE principal result of my researches is that the voltaic arc is the seat of a perfectly defined physical phenomenon, the boiling or vaporisation of carbon.

It has been known for a long time that the brilliancy of arc lamps appeared independent of the electrical energy used to produce the arc. I have found that the light from the positive carbon is perfectly independent of the electrical energy used to produce the arc, working within the following limits:—

Ampères.			Volts.			Watts.
10	...	...	50	...	...	500
400	...	...	85	...	...	34,000

Tests have been made by two very different methods. At first I worked by direct sight by means of a Duboscq spectro-photometer. This is a photometer with shutters which allow equalisation with precision of the wave lengths from two sources of light. If one of the luminous sources is formed by the end of the positive carbon, the other being the standard of light, equalisation, once established, persists in spite of the changes which one can produce in the regulation of the arc.

I afterwards made photographs of the arc under different conditions, taking care to reduce enormously the objective, and to limit the exposure to a small fraction of a second. These photographs show that the brilliancy of the positive carbon remains identically the same in every case, for the opacity of the exposed film remained constant. I may add that according to experiments by M. Blondel, impurities which ordinary carbons of commerce may contain, do not alter the brilliancy of the positive carbon.

If one takes for negative a hollow carbon, one can prove at the negative pole the condensation of carbon vapour, which forms in the interior of the tube a crystalline structure, developing itself in the manner of electrolytic deposits of lead or silver, to disappear again when the cathode is itself sufficiently heated.

The determination of the temperature of the boiling point of carbon is difficult. I have tried to measure it by the calorimetric method which I have used for refractory metals. The positive pole is formed into a thick tube containing a second tube, which holds a rod, terminated inside by a button the same diameter as the second tube. When this button has reached the desired temperature it is sufficient to pull quickly on the rod to detach it, it will then be received in a little copper cup placed in the water of the calorimeter which is under the furnace. The bottom of the cup is covered by a disc of graphite; another disc is thrown on the button, transformed itself into graphite after this has fallen in the cup, then the cup is closed with its cover. The heat carried down is then measured very easily by the usual method. By operating successively on buttons of different lengths, one can determine the heating effect which would be produced by a piece of graphite taken in its mass, to the terminal surface. One can measure thus very exactly the quantity of heat taken to the calorimeter by 1 gramme of graphite at its boiling point. If one knew the specific heat of carbon under these conditions, it would be easy to deduce the temperature sought. As this specific heat is imperfectly known, one can only regard as approximate the number, 3,500°, which I have put forward in a previous estimate. I hope to be able soon to give a more accurate result.

* Abstract of paper in the *Bulletin de la Société Internationale des Electriciens*, June, 1893.

NEW PATENTS—1893.

13,858. "A galvanic element." A. HEIL. Dated July 17th. (*Complete.*)

13,888. "Improvements in electric current and current generator governors." C. WIESE. Dated July 18th. (*Complete.*)

13,889. "An electrical self-winding block." J. S. BOLTON and T. J. MURDAY. Dated July 18th.

13,900. "Improvements in electric heating." R. G. BENNETT. Dated July 18th.

13,911. "An improved method of and apparatus for heating, welding, or working metals electrically." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated July 18th. (*Complete.*)

13,976. "Improvements in dynamo brushes." THE LONDON ELECTRIC WIRE COMPANY, LIMITED, and H. CAPEL. Dated July 19th.

13,992. "Electrical perforating or 'pricking' device suitable for making tracings or stencils." O. R. KNORR, C. SCHREIBER and F. O. FISCHER. Dated July 19th.

13,995. "Improvements in apparatus for the manufacture electrolytically of tubes and other articles of circular section." F. E. ELMORE. Dated July 19th.

13,996. "Improvements in vehicles and electric locomotives for single line elevated railways." F. B. BEHR. Dated July 19th.

14,000. "Improvements in and relating to electricity meters." S. Z. DE FERRANTI. Dated July 19th.

14,003. "Improvements in or connected with electric-circuit closing devices for series circuits." A. A. GOLDSTON. Dated July 19th.

14,012. "Improvements in electric batteries." H. BONNER. Dated July 19th.

14,030. "Improvements in apparatus for the suspension of electric light fittings." B. THOMAS. Dated July 20th.

14,056. "Improvements in electrolytes for primary batteries." W. H. LONGSDORF. Dated July 20th.

14,076. "Improvements in electric measuring instruments." H. H. LAKE. (Communicated by A. H. Armen, United States.) Dated July 20th. (*Complete.*)

14,087. "Improvements relating to incandescence lamps." H. H. LAKE. (Communicated by the General Electric Company, United States.) Dated July 20th.

14,089. "Improvements relating to the manufacture of Paris blue or Berlin blue, and of Berlin green, by electrolysis, and to apparatus chiefly designed for use in such manufacture." H. GOEBEL. Dated July 20th. (*Complete.*)

14,091. "Improvements relating to electric fuses." F. W. T. BRAIN. Dated July 21st.

14,105. "Illumination in connection with electric gas lighters." A. ECKSTEIN and H. J. COATES. Dated July 21st.

14,130. "Improvements in the electrolysis of iodides, bromides, nitrates, and other salts." J. HARGREAVES and T. BIRD. Dated July 21st.

14,131. "Improvements in the electrolysis of chlorides, iodides, bromides, nitrates, and other salts, and in apparatus therefor." J. HARGREAVES and T. BIRD. Dated July 21st.

14,155. "Improvements in and connected with break-feed appliances for electric arc lamps." F. J. BEAUMONT. Dated July 21st.

14,157. "Improvements in or relating to electricity meters." H. W. C. COX. Dated July 21st.

14,158. "A new or improved electric lifeboat messenger and tender." A. BROWNE. (Communicated by J. A. Cox and A. W. Read, India.) Dated July 21st.

14,202. "Improvements in multipolar dynamo-electric generators and motors." L. PYKE and E. S. HARRIS. Dated July 22nd.

14,210. "An improvement in tubular posts for telegraphic or other purposes." SIEMENS BROS. & COMPANY, LIMITED, and C. E. J. MAY. Dated July 22nd. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

1,497. "Improvements in couplings for electric wires." A. SHIELS. Dated January 26th. The inventor makes the two parts or clamps of the coupling, preferably of the shape described in patent No. 20,367, 1891. The parts or clamps of the coupling are made of suitable conducting material and are merely connected together. No contact springs or plugs are used, as the metal itself serves as the conducting medium. The parts of the coupling may be covered or coated on the outside with a suitable insulating material. When the coupling is to be used for two wires, the coupling itself serves as the connection for the one wire, whilst the other wire is led up the centre of each clamp to a contact piece, which is inserted in the middle or other part of a vulcanite or other non-conducting plug, fitted in the clamp. The vulcanite plug is preferably surrounded, as usual, with a rubber ring or washer. 4 claims.

3,030. "Improvements in and relating to the lighting of railway vehicles by electricity, and to apparatus therefor." H. H. LAKE. (Communicated from abroad by the Consolidated Car Heating Company, of America.) Dated February 16th. A single generator for the train is carried by the locomotive preferably on the front axle of the forward truck, where, among other advantages it is quite accessible and is less exposed to dust than anywhere else outside the cars. This generator is constructed in a peculiar manner requiring no brushes or wire on the armature, and securing it in such manner that the jolting and jarring due to unevenness of grade or imperfections in the road bed will not make it a source of danger to the axle of the truck. A further provision consists in employing in connection with the generator a storage battery or batteries. 23 claims.

3,443. "Improvements in electric arc lamps." G. HUGHES. (A communication from abroad by C. H. O. Japy and O. Helmer, of Paris.) Dated February 22nd. In this improved electric lamp the continuous feeding of the carbons takes place at short intervals as well as when the ignition takes place, the whole being actuated by a jointed mechanism combined with clock work provided with an equilibrated pallet escapement, or a fly escapement pivoting about the axis of the toothed motor wheel and raising the upper carbon at the same time as the lower carbon is lowered, this motion being differentially carried out under the action of the electric current by means of a solenoid with fine wire for the one direction, and by means of a solenoid with coarse wire for the other, the first being placed in derivation upon the two binding screws of the lamp and the second in the main circuit. 7 claims.

4,017. "Improvements in electric measuring instruments." H. H. LAKE. (Communicated from abroad by E. Weston, of America.) Dated March 1st. Depends upon the principle that a wire when heated by a current passing through it will expand, and that the extent of the expansion or elongation bears a relation to the current, strength, or pressure. 4 claims.

4,578. "Improvements in and relating to applying carbon filaments to electric lamps." A. C. CAREY. Dated March 8th. The inventor takes an exhausted or dead lamp, and by heat reduces the teat to a plastic state, pushes a suitable tool through it and enlarges the opening. The exhausted filament is then removed and the leading-in wires cleaned of adhering parts. If the bulb be foul, it may be cleansed by brushes or other means. He then takes a new filament and fastens to its ends, by cement or other means, metallic couplings, and inserting the filament thus supplied with couplings into the bulb, he connects the couplings with the leading-in wires and completes the union by pinching the couplings about the leading-in wires, or by adding cement in those portions of the couplings which are to receive the leading-in wires, or by soldering or electric welding, or other means. A glass tube having a flaring mouth is then applied to the opened end of the bulb, the air is exhausted from the bulb, and the bulb sealed by melting the tube and closing it and the tube then removed, the lamp being then ready for duty.

4,691. "Improvements in secondary electric clocks." E. SCHWEIZER. Dated March 9th. Relates to secondary electric clocks wherein the catches or levers for actuating the hands of the dial are actuated by means of an oscillating armature influenced by the poles of an electro-magnet. This oscillating armature is applicable both to secondary electric clocks that are worked by alternate positive and negative currents, as also to such as are actuated by a positive or a negative current flowing in one and the same direction. 8 claims.

5,086. "Improvements in electric block signalling apparatus." W. P. HALL. Dated March 15th. Claims:—1. In a block signalling apparatus the combination with a series of normally closed rail circuits, of a series of normally open or broken signalling circuits, each signalling circuit including a normally open circuit-closer constructed to be closed by the action of the train upon one of the rail circuits and also including a normally closed circuit breaker constructed to be opened by the action of the train upon the next succeeding rail circuit of the line, substantially as and for the purpose set forth. 2. In a block signalling apparatus the combination with a series of normally closed rail circuits, of a series of normally open or broken signalling circuits, each signalling circuit including a normally open circuit-closer constructed to be closed by the action of the train upon one of the rail circuits and also including normally closed circuit-breakers constructed, on each alternate signalling circuit, to be opened by the action of the train upon the two next succeeding rail circuits of the line, and on the intermediate signalling circuits to be opened also by the action of the train on the third succeeding rail circuit of the line, substantially as and for the purpose set forth.

6,112. "Improvements in and relating to secondary batteries or accumulators." H. H. LAKE. (Communicated from abroad by W. Sleicher, jun., and G. A. Mosher, both of America.) Dated March 29th. Consists broadly of a supporting element of insulating material which carries the active material and also the electrical conductor in contact with the active material. 8 claims.

6,119. "Improvements relating to electric railways." M. A. CATTORI. Dated March 29th. Mainly consists in the method of arranging the circuit breaker which serves for breaking or closing the circuit, as the case may be, between the single sections which form the electric conductor for series system electric railways, or for parallel railways whose current conductors feed the sections in shunt. 1 claim.

6,569. "Improvements in telephone cables." J. E. KINGSBURY. (A communication from abroad by the Western Electric Company, of Chicago.) Dated April 5th. In this invention paper tape is employed which is corrugated transversely at the centre, the edges being left unbroken so that the tape may have sufficient strength to permit it to be wound upon the wire; a cable is also formed, the separate wires of which are insulated by paper tape corrugated tranversely at the centre; said tape when wound upon the wires becomes contracted or puckered at the centre on account of such softening or partial cutting away of the centre so that the thickness of the covering composed of the central or corrugated portion of the tape will be greater than at other portions thereof. In this manner a spiral ridge of loose texture or consistency is formed about each wire. 4 claims.

6,961. "Improvements in automatic switches for electrical apparatus." A. HEIL. Dated April 11th. Relates to a species of automatic switches for use with electric lamps and other electrical apparatus where the necessity exists that a circuit which has been in any way broken, either by accident, mistake, or injury, should as rapidly as possible be substituted by another, into which is interposed an electric arrangement, for a purpose equal or similar to that of the arrangement which has become useless by reason of interruption. 2 claims.

7,044. "Improvements in dynamometers." E. J. WOOD. Dated April 12th. Relates to improvements in dynamometers in which a record-receiving disc or strip is actuated independently of the power-transmitting and power-applying mechanism, and a marker, subject to the varying relation of the said power-transmitting and power-applying devices, is arranged to make the record upon the disc or strip, of the amount of power expended. 5 claims.

7,398. "Improvements in telephone receivers." E. C. HESS. Dated April 19th. The object of the invention is to so construct a telephone receiver that it can be applied to both ears of the person using the receiver at one and the same time, and to so construct the receiver that the ear-pieces will fit tightly to the ears. 5 claims.

11,119. "Improvements in electric switches." F. BROADNAX. Dated June 14th. Claims:—1. In a double pole switch, a rotating cam provided with a series of faces of conducting material, such as metal and non-conducting material such as glass, in the form of steps, the contact plates of each set being placed diametrically opposite each other and connected together by a conductor upon and around which the insulating material of which the cam is formed is moulded. 2. In an electric switch, a rotating cam provided with a series of faces of conducting and non-conducting material in the form of steps, the conducting faces being provided with an insulating ledge extending beyond and flush with the conducting plate. 3. In an electric switch, a coupling piece provided with a plurality of intersecting screwthreaded apertures having an angular relation to each other, combined with a suitable set screw. 4. In a double-pole switch, a rotating cam provided with a series of faces of conducting material, such as metal, and non-conducting material such as glass, in the form of steps, the contact plates of each set being placed diametrically opposite each other and connected together by a conductor of irregular form upon and around which the insulating material of which the cam is formed is moulded.

11,403. "Improvements in electric generators and motors." W. T. GOOLDEN and L. B. ATKINSON. Dated June 17th. Has for its object the special construction and arrangement of covers over the armature, commutator, and brushes, broadly, according to the description in specification of letters patent No. 12,676, dated September 19th, 1887, but with special regard to means for removing the covers with great facility for inspection and repairs, for adjusting and regulating the positions of the brushes upon the commutator from the exterior and for keeping the enclosed volume of gas or atmosphere within the case as small as possible, by the use of pockets or recesses for containing the brushes. 4 claims.